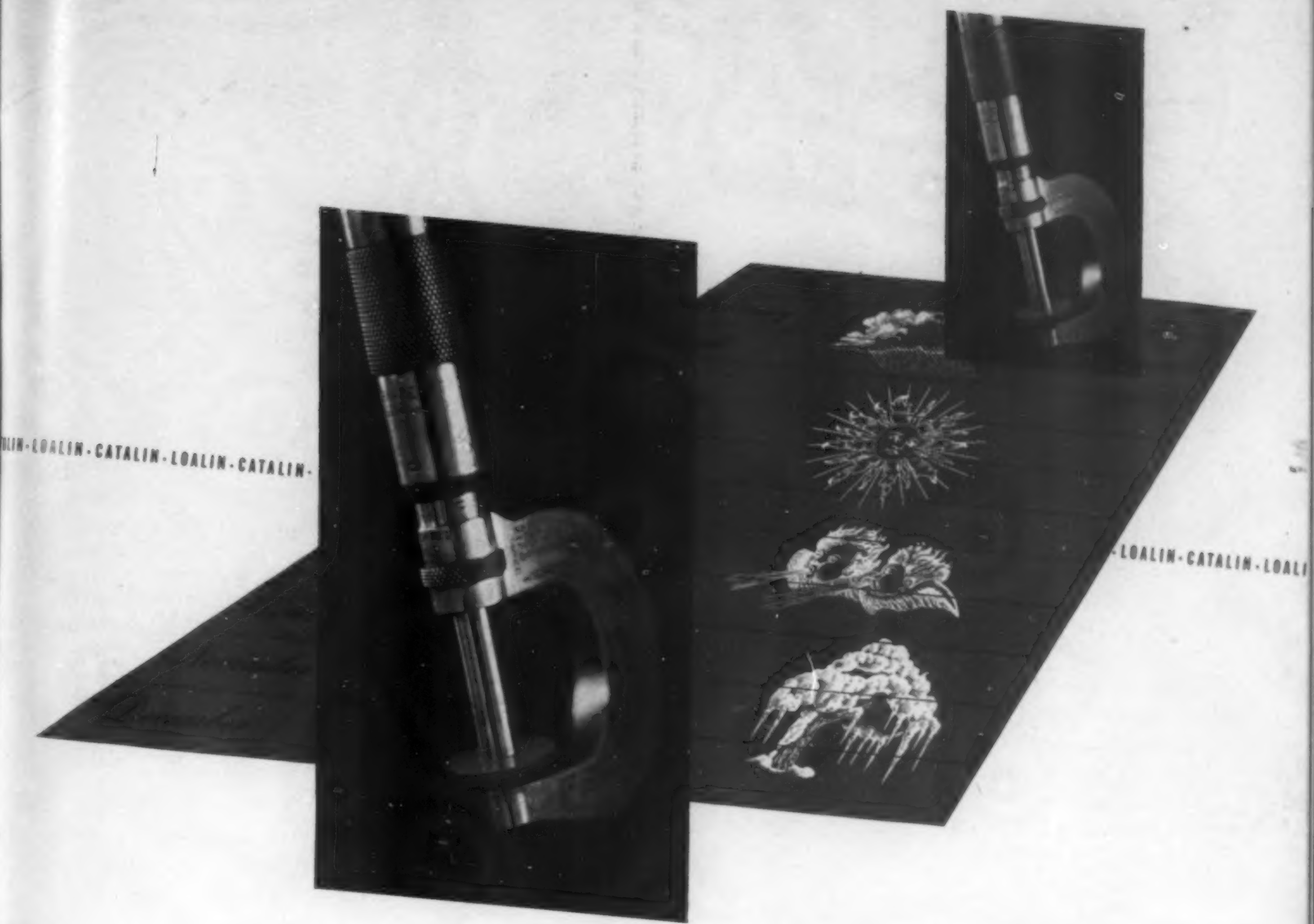
MODERN PLASTICS

APRIL 1943



dimensional stability

Dimensional Stability is not, strictly speaking, a physical property. Rather, it is the sum of many physical properties proving themselves under actual test in a variety of climatic conditions and over a period of time.

The true measure, therefor, of the dimensional stability of any plastic material is dependent upon the ultimate use to which it is to be put. It is when a material maintains its size characteristics under different use conditions and applications that we speak of it as having "high" dimensional stability.

We are proud to offer a new, tough thermosetting "CATALIN" cast resin, possessing a higher degree of dimensional stability than any before available. Its negligible shrinkage in service (.00018 in. per in.)—resistance to high temperatures — low water absorption and high compressive strength (25,000 lbs. per sq. in.) marks this new "CATALIN" a perfect material for drill jigs, forming dies and other wartime applications where it is replacing scarce metals and saving manhours.

Under conditions of extreme cold or humidity, "LOALIN"—our polystyrene molding compound—will show little or no variation from the close tolerances to which it originally may be molded. "Zero" water-absorption is an important factor in making its superlative performance possible.

For current wartime applications and for planning now for the mass-production that shall come with peace, "CATALIN" engineers and chemists will gladly share their rich store of knowledge and experience with members of your technical staff.

Cast Resins
Molding Compounds
Liquid Resins

CATALIN
CORPORATION

ONE PARK AVENUE • NEW YORK, N. Y.

ONE · OF · A · SERIES · ON · THE · PHYSICAL · PROPERTIES · OF · PLASTIC · MATERIALS

modern plastics

INCLUDING *Plastics* ENGINEERING

VOLUME 20 — APRIL 1943 — NUMBER 8

GENERAL INTEREST

PLASTICS ENGINEERING

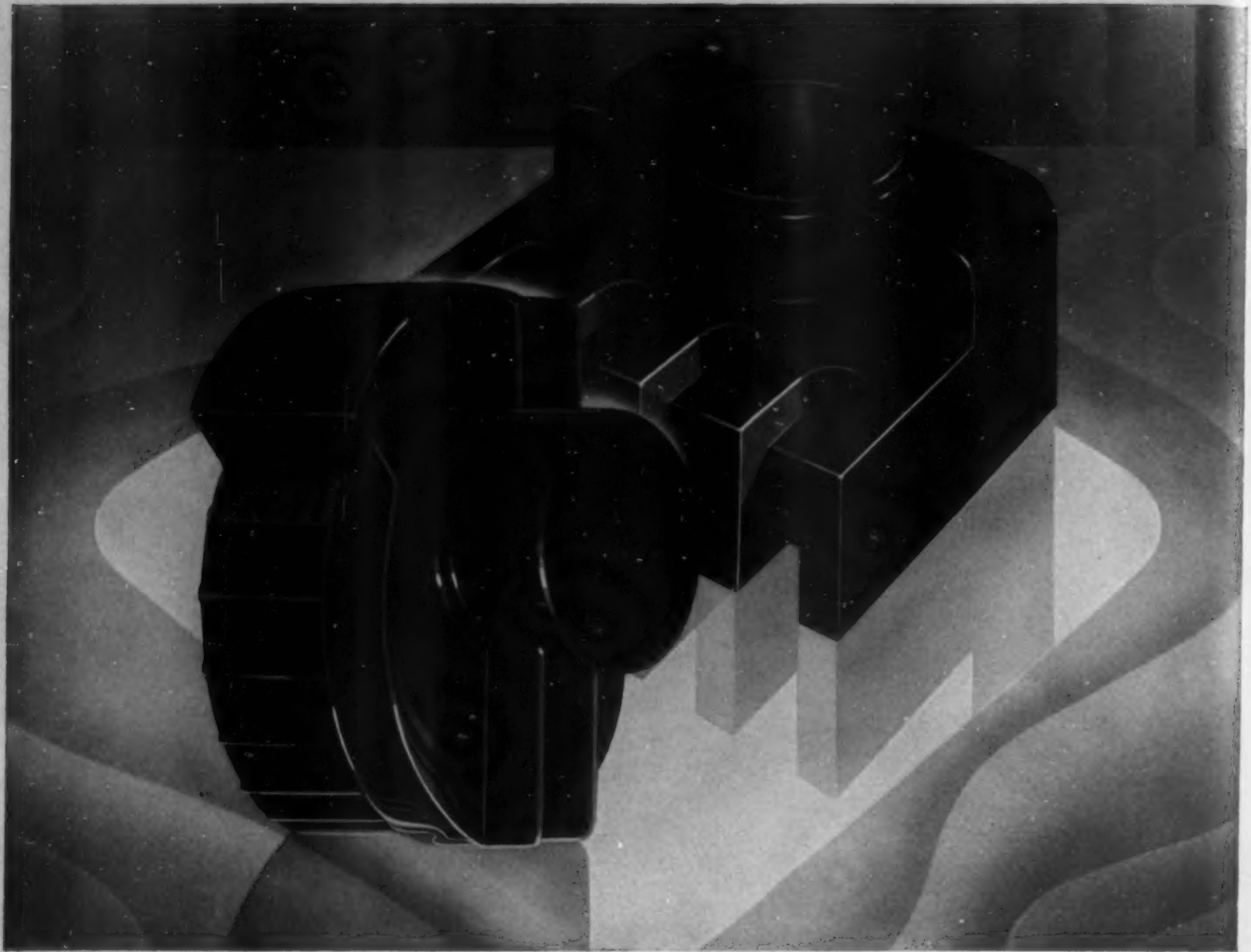
TECHNICAL SECTION

NEWS AND FEATURES

EXECUTIVE and EDITORIAL OFFICES: 122 E. 42nd St., New York, N. Y. WASHINGTON, D. C. OFFICE: 625 Colorado Bldg., 14th & G. Sts.

Published the 5th of each month by Modern Plastics, Incorporated. Publication Office, Twentieth and Northampton Sts., Easton, Pa. Subscription price $5.00 per year, $8.00 for 2 years in U. S., its possessions and South America. Canadian subscriptions $5.50 per year, $9.00 for 2 years; all other countries, $6.00 per year, $10.00 for 2 years, payable in American money or its equivalent. Price 50¢ per copy.

Entered as second class matter May 28, 1940, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations. Back numbers 3 months or more preceding current issues, when available, $1.00 each.



They won't be miracles tomorrow

MANY MATERIALS, parts and products miraculously developed to meet wartime needs will be standard commodities "tomorrow." Their immediate acceptance will be assured because of the wide usage and thorough testing by the armed forces.

Such materials as Laminated INSUROK will be formed to meet scores of postwar needs—fabricated to fit a postwar economy. Many a wartime Molded INSUROK part is the forerunner of an improved civilian product—of a more efficient industrial tool.

Because Richardson Plasticians have had so many years of prewar experience—have been fully engaged in war product development work—they are particularly well qualified to help you solve problems involving the design and fabrication of plastics—for immediate or postwar use. Just send in your designs for their recommendations, or write for data covering the various grades of Laminated or Molded INSUROK.

The Richardson Company, Melrose Park, Ill.; Lockland, Ohio; New Brunswick, N. J.; Indianapolis, Ind. Sales Offices: 75 West St., New York City; G. M. Building, Detroit, Mich.

INSUROK ***and the experience of Richardson Plasticians are helping war products producers by:***

1. Increasing output per machine-hour.
2. Shortening time from blueprint to production.
3. Facilitating sub-contracting.
4. Saving other critical materials for other important jobs.
5. Providing greater latitude for designers.
6. Doing things that "can't be done."
7. ✓ Aiding in improved machine and product performance.

INSUROK

MADE AND SOLD ONLY BY THE RICHARDSON COMPANY

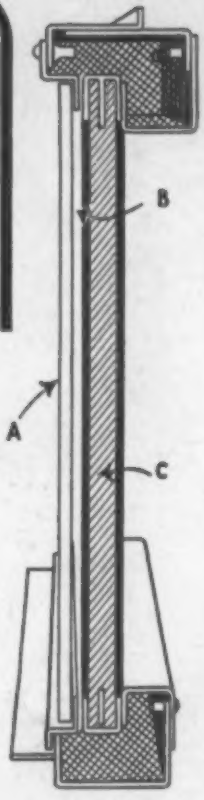
New bird-resistant windshield for aircraft

INTERLAYER OF DU PONT *"Butacite"** TO HELP PROTECT PILOTS IN COLLISION WITH LARGE BIRDS

Picture a large bird hurtling through an airplane windshield—spraying the pilot with broken glass—bursting through the bulkhead—racing the length of the cabin—piercing the baggage compartment! Accidents like this sometimes happen even at altitudes of 8000 feet, when pilots collide with ducks, wild geese, eagles—even sea-gulls.

Recently, under the auspices of the Civil Aeronautics Administration, researchers began development of a new-type windshield to protect pilots from such high-velocity impacts. The astounding result of their tests: a windshield laminated with special Du Pont "Butacite" polyvinyl acetal resin—capable of withstanding the impact of fifteen-pound birds at velocities of over 200 miles per hour! Follow this amazing story in pictures, below.

**"Butacite" polyvinyl acetal resin*



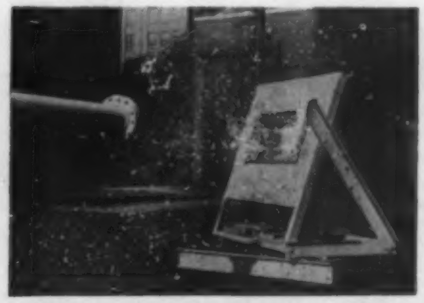
Cross-section of windshield shows (a) $\frac{1}{4}$'' glass front pane, (b) hot air space for deicing and maintenance of correct temperature for maximum impact strength of laminated section, (c) laminated section of $\frac{1}{2}$'' "Butacite" between $\frac{1}{8}$'' semi-tempered glass panes. Metal strips, imbedded in flange of "Butacite," allow firm bolting of plastic to metal framework.

1 Westinghouse compressed-air gun aims dead birds at windshield of DC-3 Air Transport. Gun develops velocities up to 400 m.p.h....

2 Specially - constructed framework, patterned after that of DC-3, holds test windshields as targets.

3 Air-gun is primed with bird-carcass before test is made. Firing velocities are adjusted by air pressure and distance from target.

4 Gun is fired. Ordinary windshield is shattered completely by dead - bird projectile shot at low velocity.



5 Carcass fired at new-type windshield shatters glass front-pane, but bounces off the laminated section.

6 Laminated section cracks but remains intact. Thus Du Pont "Butacite" will provide greater safety for the men who fly the skyways.

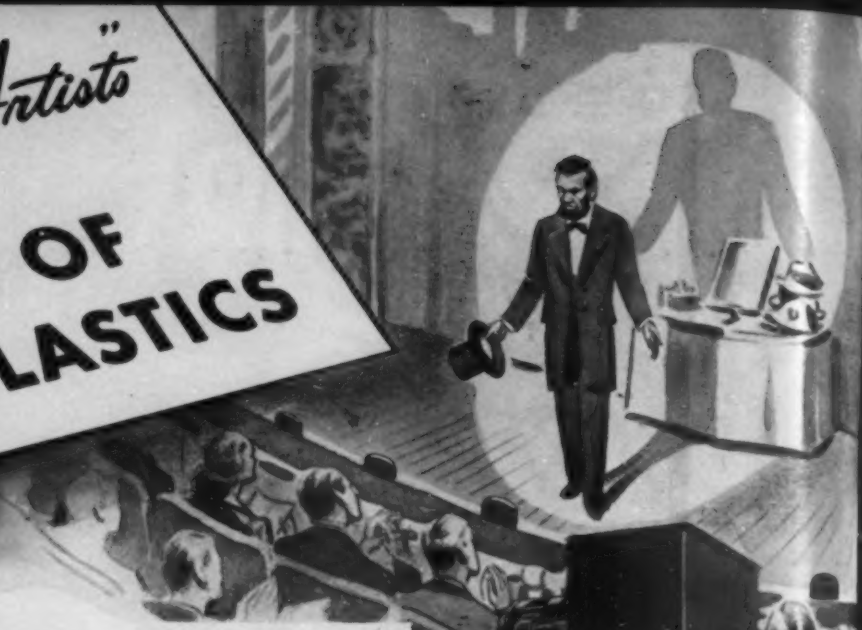
This application of "Butacite" polyvinyl acetal resin is one example of how Du Pont Plastics Technicians are helping to provide things for greater safety and efficiency in war, as well as in peace. Let us help you solve your development problems! Write: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, New Jersey.

DU PONT
REG. U. S. PAT. OFF.

PLASTICS

Better Things for Better Living . . . THROUGH CHEMISTRY

THESE "*Lightning Change Artists*" SERVE THE MOLDERS OF MODERN PLASTICS



You may remember the old-time "lightning-change artist," and how he "brought down the house" with amazing transformations.

Rapid change-overs of another kind earn applause from molders of modern plastics. In the machines they use, speedy adaptability is of greater and greater value. War needs call for sudden transformations, and so will the needs of post-victory industries.

Watson-Stillman molding machines are quickly convertible. By the change of a die, they are made ready for new and different work.

The Watson-Stillman line includes injection molding machines as well as compression molding machines. Each unit is built to precision standards on modern automatic machinery. Each is built under the supervision of W-S engineering personnel. W-S representatives, available to advise you on present and future problems, have been familiar with plastics since the very beginning of the industry.

Research for post-war developments is being materially expanded at Watson-Stillman. Today, and in the years to come, the pooled experience of our entire organization can help industry to anticipate its needs. It is not too early now to consult W-S engineers. The Watson-Stillman Co., Roselle, N. J., manufacturers of injection molding machines; fully-automatic compression molding machines; semi-automatic compression molding machines; hand molding presses; multiple steam platen presses.

Fully automatic compression molding machine.

WATSON-STILLMAN

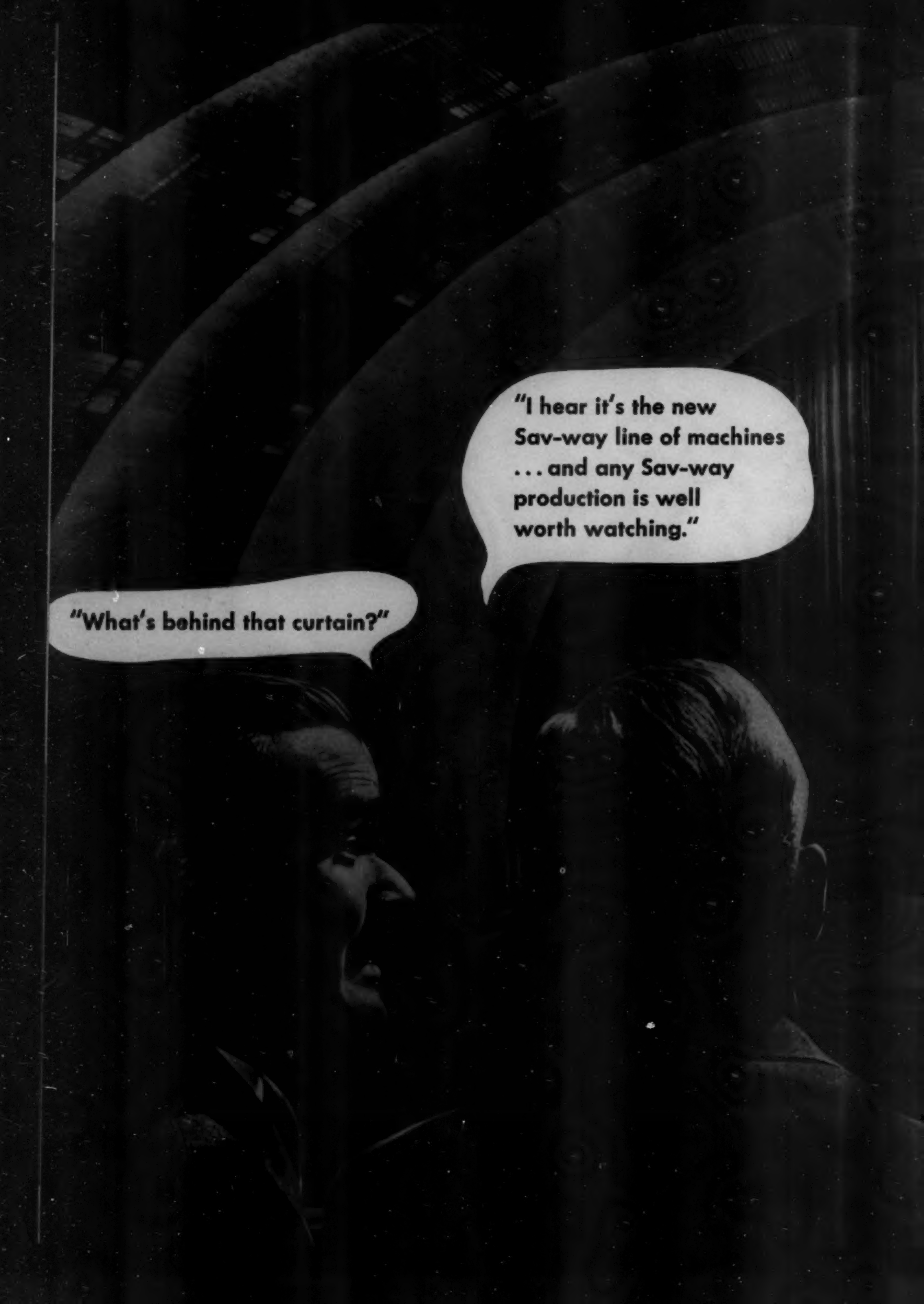
Hydraulic Equipment, Valves, Forged Steel Fittings

Semi-automatic compression molding machine.

Injection molding machine.

Let's all be Scrappers For Victory

©3760


"What's behind that curtain?"
"I hear it's the new Sav-way line of machines . . . and any Sav-way production is well worth watching."


Photograph courtesy of
RADIO CITY MUSIC HALL
Keep an Eye On
Sav-way INDUSTRIES
4875 EAST EIGHT MILE
DETROIT, MICHIGAN
Representatives throughout U. S. A. and Canada

Question every fastening!

In changing to plastic materials, fastening methods were compared . . . and P-K Self-tapping Screws proved the cheapest and best

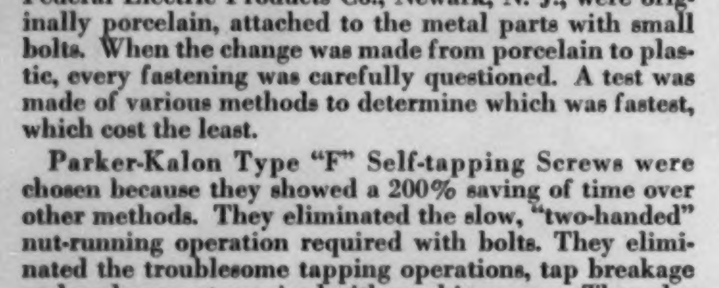
The fuse blocks in the two-circuit panels, made by Federal Electric Products Co., Newark, N. J., were originally porcelain, attached to the metal parts with small bolts. When the change was made from porcelain to plastic, every fastening was carefully questioned. A test was made of various methods to determine which was fastest, which cost the least.

Parker-Kalon Type "F" Self-tapping Screws were chosen because they showed a 200% saving of time over other methods. They eliminated the slow, "two-handed" nut-running operation required with bolts. They eliminated the troublesome tapping operations, tap breakage and replacement required with machine screws. They also reduced rejects, and breakage caused by screws backing out when loosened by vibration.

Because P-K Type "F" Screws tap their own strong threads as they are driven, no tapping, no costly metal inserts, are necessary. One easy operation – turning the screws into drilled or molded holes – makes a more secure assembly than machine screws in tapped holes.

Call in a P-K Assembly Engineer to check over metal and plastic fastening jobs with you. He can help you search out *all* opportunities to apply P-K Self-tapping Screws. And, he'll recommend them only when they'll do the job better and faster. If you prefer, mail in assembly details for recommendations. Parker-Kalon Corporation, 190-200D Varick Street, New York, N. Y.

Two P-K Type "F" Screws are used to hold the brass terminals to the bakelite fuse block; another, at the top, to hold the brass neutral to the bakelite terminal block. The thickness of the brass is .064", of the bakelite, .375". The panels are widely used in Army cantonments, Navy barracks, and industrial buildings.



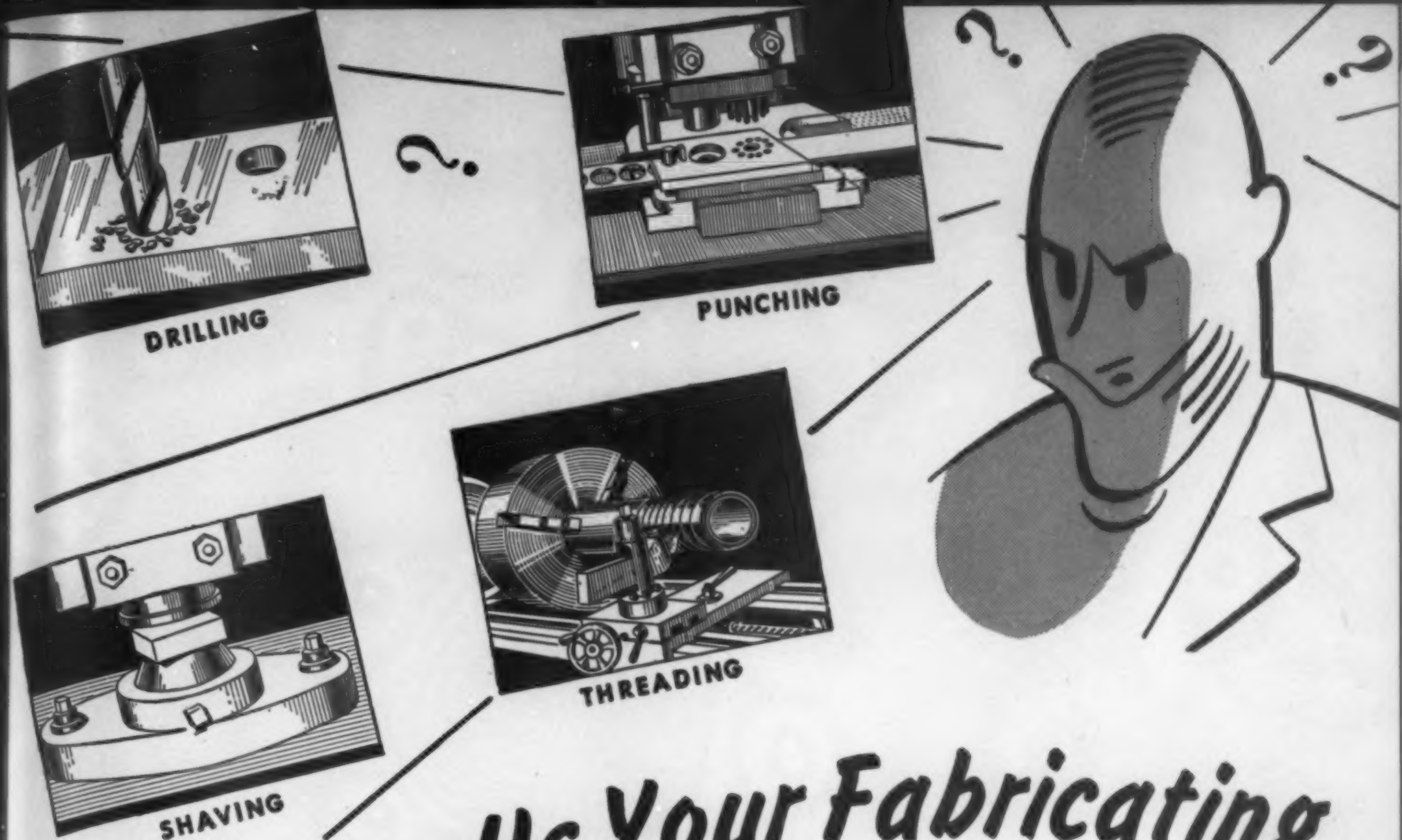
A TYPE FOR EVERY METAL OR PLASTIC ASSEMBLY

PARKER-KALON

Quality-Controlled

SELF-TAPPING SCREWS

Give the Green Light • to War Assemblies



Bring Us Your Fabricating Problems on...

NATIONAL VULCANIZED FIBRE & PHENOLITE

Today's war production demands call for the conservation of materials through proper methods of handling. In the machining and fabrication of National Vulcanized Fibre and Phenolite, years of experience have taught us efficient practices—valuable short cuts. This worth-while technical information is available to you for the asking. Our engineers will be glad to work with your production men on any National Fibre or Phenolite fabricating problem. Write or call us.

DELIVERIES of National Vulcanized Fibre and Phenolite are confined to products necessary to the War Effort. However, it is our sincere desire to meet the demands of all of our customers and to serve them to the full extent of the limitations placed upon us. You can depend on our doing this.

NATIONAL VULCANIZED FIBRE CO.

WILMINGTON DELAWARE

Offices in Principal Cities

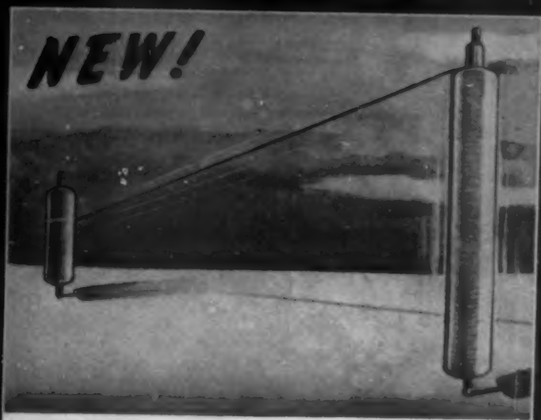
You can profitably use these technical Hand Books. Write for Free Copies on your company letterhead.

NEW PLAX POLYSTYRENE PRODUCTS OPEN NEW INSULATION HORIZONS

POLYFLEX SHEET

(TOUGH and FLEXIBLE Polystyrene Sheet)

Produced from .001" to .020" thick in rolls 20" wide, and cut in any width to meet your specifications, Polyflex Sheet is an *improvement* — not a substitute — in storage batteries, condensers, cable, etc.



POLYFLEX FIBER

(TOUGH and FLEXIBLE Polystyrene Fiber)

Another *new* Plax development, now in commercial production from .010" to .060" thick, Polyflex Fiber has tremendous possibilities for cable wrapping and other high-frequency insulation needs.

PLAX POLYSTYRENE CHARACTERISTICS

(Apply to all Plax products shown here)

.00 water absorption (lowest of all plastics.)

Unaffected by weather, acids, alkalis, alcohol, stack gases, etc.

Dielectric strength of excellent mica.

Low dielectric loss of fused quartz.

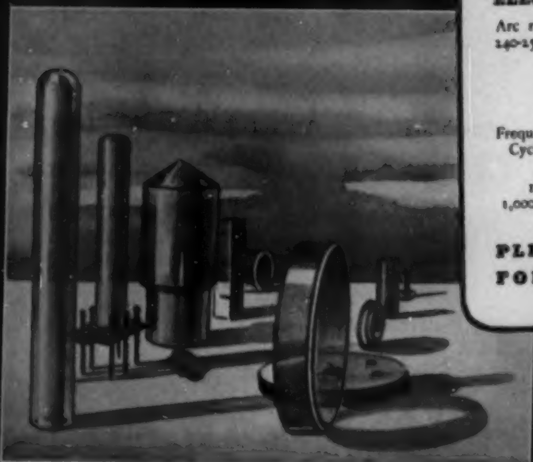
ELECTRICAL PROPERTIES

Arc resistance (ASTMD-495-38T) sec 240-250. Dielectric strength, volts/mil:

.005" thick=3500
.010" thick=2500
.015" thick=2200
.125" thick=500-700

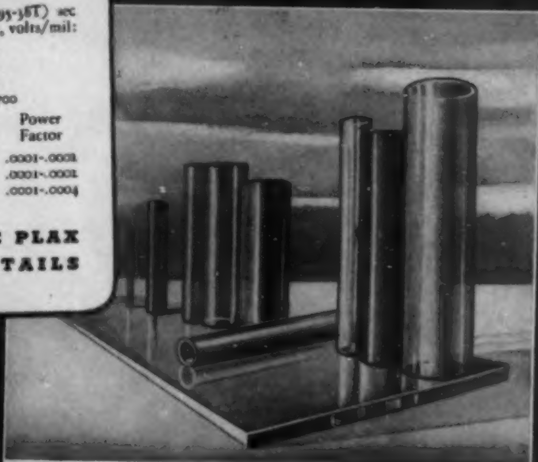
Frequency Cycles	Dielectric Constant	Power Factor
60	2.5-2.6	.0001-.0002
1,000	2.5-2.6	.0001-.0002
1,000,000	2.5-2.7	.0001-.0004

PLEASE WRITE PLAX FOR FULL DETAILS



MACHINED Polystyrene Parts

From polystyrene sheet, rods, and tubes, Plax machines special and standard electronic parts in any quantity, of unusual accuracy, in a surprising range of sizes. Deliveries are prompt and complete.



POLYSTYRENE sheet, rods, & tubes

Available to those who prefer to buy Plax Polystyrene to machine themselves, into new type antenna components, stand-off insulators, buss bars, windows, etc.

(Also available in sheets, rods, and tubes: cellulose acetate, cellulose acetate butyrate, and methacrylate.)

PLAX CORPORATION 133 WALNUT ST. HARTFORD, CONN.

WOULD YOU LIKE TO HEAR US . . .

THUMP OUR CHEST?

And boast about how we are meeting
every delivery promise?
And never turning any customer away
who wants molded parts?
And never make a mistake?
And always make pieces within the tolerances specified on the blueprints?
Maybe we all need a good laugh—and
that would certainly raise one.
But, Mister, we're trying hard—
And our aim and ambition
Is to tell you, our customer, when we
slip,
Before you find out,

And humbly admit our error
With a promise to tighten up—
Which we sometimes do.
Confession is good for the soul—
And extra good for production.
At least it turns the stone over
So you can see what's underneath
Or is that last a good comparison
For an ad?
But let it ride—it says what we mean—
You know where you are if you work
with us,
Even if you're not anywhere.

"A Ready Reference for Plastics" written for the layman is now in a new edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

ARMY E NAVY

BOONTON MOLDING COMPANY

MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO-PLASTICS

BOONTON · NEW JERSEY · Tel. Boonton 8-2020

N. Y. Office—Chanin Bldg., 122 East 42nd Street, Murray Hill 6-8540

Voice of the A. E. F.

A. Milled, drilled, and turned variometer stator mounting. B. Turned high-tension insulator. C. Milled and drilled spacing strip.

SECONDS after the U. S. landing in Africa, orders to troops were winging their way by portable radio. There are dozens of applications for Synthane as insulation in radio equipment of this kind. Most important use is to prevent undue loss of minute high-frequency currents.

Long before Synthane entered the armed services it was valued for its many combined properties—resistance to corrosion from solvents, acids, salts and water . . . structural strength . . . light weight (half that of aluminum) . . . hardness, excellent insulating characteristics, and ease of machining. Some day it will return again to civilian ways, with more uses, it now seems certain, than ever before. Meanwhile, keep posted on Synthane with information such as you will find on the back of this page.

SYNTHANE CORPORATION, OAKS, PENNSYLVANIA

Plan your present and future products with Synthane Technical Plastics

SHEETS • RODS • TUBES • FABRICATED PARTS — SYNTHANE — SILENT STABILIZED GEAR MATERIAL

Bakelite—laminated

Corrosion-Resisting SYNTHANE

SYNTHANE, a laminated phenolic plastic, may be more familiar to you for its physical, mechanical and electrical properties. More recently, through research and development, grades of SYNTHANE have been found of great value as corrosion-resisting materials. Parts made from SYNTHANE have successfully resisted the effects of corrosive waters and atmospheres, chemical salts and solutions, solvents, gasolines, oils, greases, and other petroleum products. The corrosion-resisting possibilities of SYNTHANE for your application may be well worth examining. Only by examination can they be accurately determined.

SYNTHANE is available in sheets, rods, and tubes, fabricated parts, and in parts made by molding the impregnated base materials.

Corrosion-Resistance Factors

The corrosion resistance of any material is usually relative. The degree of corrosion resistance depends generally upon a combination of factors —the nature, concentration, and temperature of the chemical or corrosive agent, time of exposure, degree of agitation, and moisture absorption and chemical reactivity of the material itself.

For example, 10% solutions of either sulphuric acid or potassium dichromate have little effect on SYNTHANE. But if the two are mixed in the presence of organic matter, a vigorous oxidizing action occurs which will destroy any synthetic resin.

Corrosion-Resistance Economics

SYNTHANE is not immune to all corrosion conditions. Nor is any material.

Multiple-type plating rack assembled from SYNTHANE tubing

Corrosion-resisting piping and couplings made from SYNTHANE

Yet it need not be 100% corrosion-proof to be economically practical.

In many instances SYNTHANE is used—not because it is completely corrosion-proof—but because it retains its size, shape and strength and has a longer life per dollar invested than other materials, taking into consideration labor and material for the original installation and the cost of replacements.

Base Materials

Selection of the base material must be made with care since in nearly every case it is the base rather than the resin that is first affected.

Cotton cloth base is satisfactory for weak acids, weak bases and low concentrations of salts, or neutral salts in any concentration. Asbestos base is used for strong alkaline conditions or highly concentrated salt solutions which tend to hydrolyze or split into alkaline radicals. Asbestos is not recommended for acids or acid salts even in low concentrations. Glass cloth base is recommended for strong concentrations of acids or acid salts, and is excellent for those conditions. Special corrosion-resisting resins are used for corrosion-resisting SYNTHANE.

When to Use Synthane

We prefer to examine each application individually. If a previous experience does not approximate yours, laboratory and commercial tests will be made to reach a solution profitable and practical in your case.

The Effect of Chemicals

In general, any concentration and temperature up to 180° Fahr. of the salts of the following metals will not affect SYNTHANE except to produce a slight change in its color:

Aluminum	Copper	Mercury
Barium	Iron	Nickel
Bismuth	Lead	Silver
Cadmium	Magnesium	Tin
Cobalt	Manganese	Zinc

Calcium (except hypochlorite)
Potassium (except hydroxide)
Sodium (except hydroxide and hypochlorite)

Synthane Also Resists the Following Solvents:

Aliphatic hydrocarbons	Ketones at room temperature
Aromatic hydrocarbons	Alcohols, esters and ethers

Chlorinated hydrocarbons (except those which have hydrolyzed; for example, carbon tetrachloride in the presence of moisture)

Synthane Will Not Resist:

Chlorine gas, wet or dry
Sodium hypochlorite
Chlorine water
Sodium hydroxide over 2%
Potassium hydroxide over 2%
Calcium hypochlorite
Bromine and bromine water
Pyridine

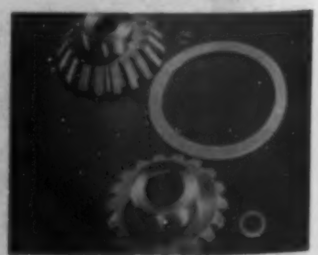
SYNTHANE will resist the following acids at the concentrations noted at room temperature:

Acetic 50%	Formic conc.
Benzoic conc.	Hydrochloric 10%
Boric conc.	Hydrofluoric 20%
Phenol 10%	Lactic conc.
Chromic 45% (special resin required; intermittent exposure as in plating)	Nitric 2%
	Oleic 5%
	Oxalic conc.
	Phosphoric 10%
	Sulphuric 15%
	Sulphurous 6%
Citric conc.	

Note: The addition of salts such as 20% sodium sulphate to 10% sulphuric acid is known to inhibit the effect of the acid for a long period of time.

A mixture of sodium hydroxide 10% and sodium cyanide 10% also shows this phenomenon. This concentration of sodium hydroxide alone would rapidly attack SYNTHANE.

SYNTHANE molded-macerated valve ball for oil well equipment



Washers and molded-macerated gears for rayon machinery

Standards of Quality Corrosion-Resisting Synthane Sheets

GRADE	C-CR Coarse Weave Fabric Base	L-CR Fine Weave Fabric Base	AA-CR Asbestos Cloth Base	A-CR Asbestos Paper Base	GLP Glass Cloth Base
TENSILE STRENGTH (1) Lbs./Sq. In.	9,500	9,000	10,000	8,000	16,000
TRANSVERSE STRENGTH (1) Lbs./Sq. In.	20,000	20,000	20,000	16,000	20,000
COMPRESSIVE STRENGTH (1) Lbs./Sq. In.	38,000	35,000	38,000	36,000	40,000
DIELECTRIC STRENGTH (2) Volts per mil (.001") Short-Time Test Step-by-Step Test	200 120	200 120	50 30	225 135	350 250
POWER FACTOR (3) at 1,000,000 Cycles	.10	.10	.15	.10	.026
DIELECTRIC CONSTANT (3) at 1,000,000 Cycles	7.0	7.0	7.5	7.0	5.9
DIELECTRIC LOSS FACTOR (3) at 1,000,000 Cycles	.70	.70	1.12	.70	.10–.25
% WATER ABSORPTION (4)	1.7	1.4	.85	.85	1.2
ROCKWELL HARDNESS	M105	M105	M110	M110	M115

The values above represent average for standard grades.

Methods Used in Testing Synthane

(1) Tests were made on 1/8" thickness at room temperature, approximately 25 deg. C., following the American Society for Testing Materials Method D-229-42.

(2) Tests were made under oil on 1/16" thickness, according to American Society for Testing Materials Method D-149-40T. (For grade AA-CR, 1/8" thickness was used.)

(3) Tests were made on 1/16" thickness at a frequency of 1,000,000 cycles, according to American Society for Testing Materials Method D-150-42T.

(4) Tests were made on pieces 3" x 1" x 1/8" thick, according to the American Society for Testing Materials Method D-229-42 after immersion in water for 24 hours at approximately 25 deg. C plus or minus 2 deg. C.

PLAN YOUR PRESENT AND FUTURE PRODUCTS WITH SYNTHANE TECHNICAL PLASTICS

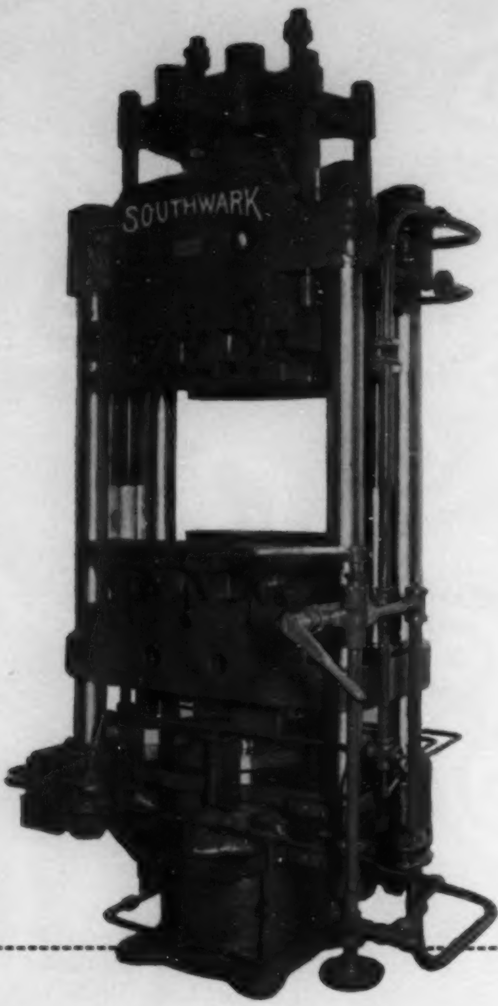
SYNTHANE

Bakelite—S—laminated

SHEETS-RODS-TUBES-FABRICATED PARTS-SILENT STABILIZED GEAR MATERIAL

SYNTHANE CORPORATION, OAKS, PENNA.

REPRESENTATIVES IN ALL PRINCIPAL CITIES



for

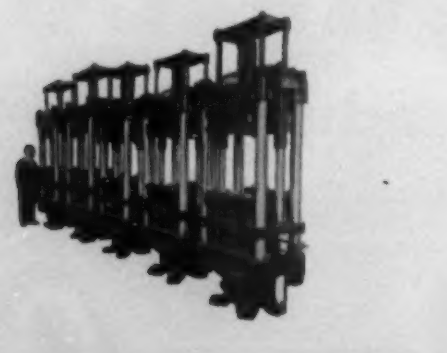
Semi-Automatic Molding–

Southwark Hydraulic Presses

Southwark is the name to look for when you need dependable plastic molding presses, for in back of every plastic piece stands the quality of the press which formed it. Southwark-built presses are noted for high-quality performance—they combine accuracy with versatility.

If you are interested in cutting down molding time, shortening time-cycles, look to Southwark Presses for the answer. With well-built molds, plastic products molded on Southwark Presses require less finishing, there are fewer fins and flashes to be removed, fewer rejects because the presses are rigid, the platens well guided.

All these features, characteristic of Southwark Molding Presses, point to one word—economy. You can save on material because close tolerances on thickness can be held, the per piece weight of the product can be kept down, costs will be lower.



B-L-H THE BALDWIN GROUP

BALDWIN SOUTHWARK

Division THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa.

KEEP EXTRUDERS *in the FIGHT!*

Proper Lubrication Pays!

The obligation for servicing Royle extruders is shared between Royle and our grand customers. Our 100% War production precludes the intimate touch with customers we at Royle covet. Thus, we must pass along to you the task of guarding your producing extruders against faulty lubrication.

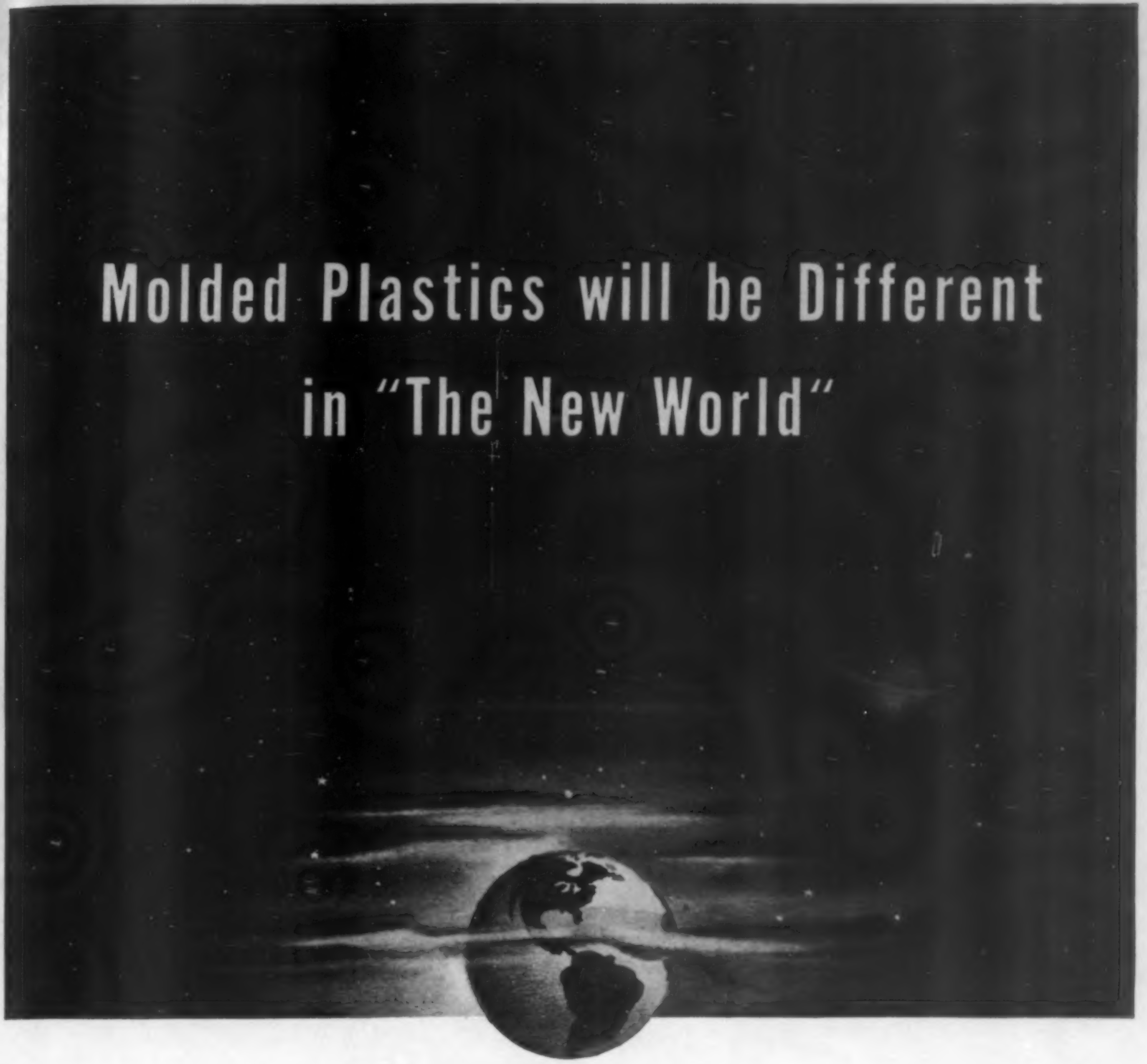
Your machines are running at 24 hour top speed. Please keep them properly lubricated. If in doubt as to the proper lubrication policy to follow, write us. Send size, type (marine, ball or roller thrust bearing . . . spur, worm or herringbone gears).

Believe us, we want to keep you running!

JOHN ROYLE & SONS

PATERSON, N. J.

AKRON: J. C. CLINEFELTER LONDON: JAMES DAY (MACHINERY) LTD.



When the eagles of war have vanished from the skies and the dove of peace lodges with us again—

And we go back to our old jobs of producing for civilian needs, we are all going to find many surprises. Things will not be just the same. Products and processes have been undergoing great change—in molded plastics, too.

We, ourselves, have been changing at General Industries. The necessities of wartime production have presented challenges that have enlarged our vision and sharpened our skills.

So that when the present big job has been finished, General Industries will be eminently qualified to produce molded plastics parts adapted to the rapidly expanding needs of the postwar world.

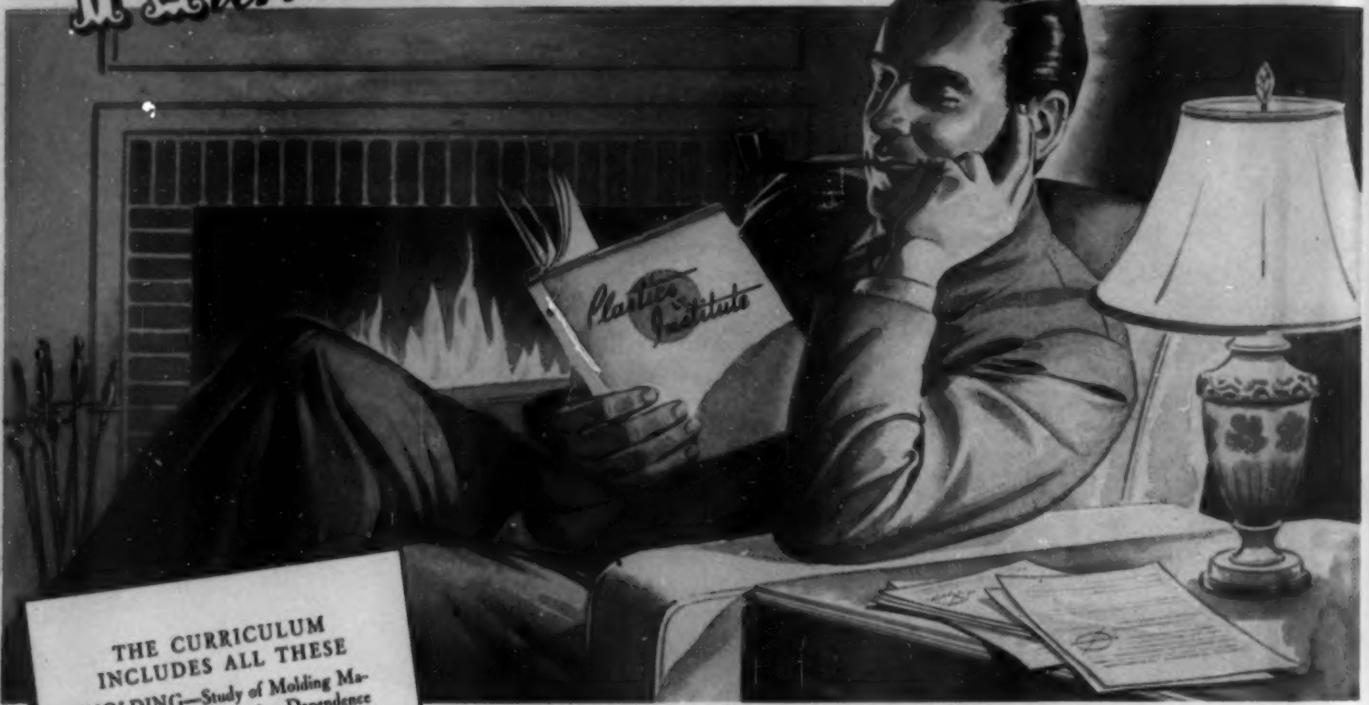
THE GENERAL INDUSTRIES CO.

Molded Plastics Division • Elyria, Ohio

Chicago: Phone Central 8431   New York: Phone Longacre 5-4107
Detroit: Phone Madison 2146   Milwaukee: Phone Daly 4057
Philadelphia: Phone Camden 2215

GENERAL INDUSTRIES
MOLDED PLASTICS

Rich rewards in studying plastics



THE CURRICULUM INCLUDES ALL THESE

MOLDING—Study of Molding Materials and Flow Properties. Dependence of Properties of Materials Upon Methods of Molding.

MOLD DESIGN AND CONSTRUCTION—Fundamental Requirements of Thermosetting and Thermoplastic Composition in Molding.

CASTING—Materials Suited for Casting Purpose. Production Techniques Developed for Casting Phenolic Resins and Acrylic Resins.

LAMINATING—Procedure of Impregnating Fabrics, Paper, Asbestos and Wood.

TECHNIQUES OF FABRICATION—Thermoplastic Qualities of Plastic Materials.

TESTING—Why Plastics Differ from Other Materials of Construction and Wherein Test Methods Will Differ.

DESIGNING AND STYLING WITH PLASTICS

Historical Background. Polymerization Phenomena and the Formation of Plastics. Introduction to Organic Chemistry. Formation of Phenolic Plastics. Urea Resins and Their Characteristics. Polyvinyl Resins and Their Characteristics. Acrylic and Polystyrene Resins. Cellulose Plastics — Origin and Chemistry. Introduction to Cellulose Chemistry. Utilization of Farm Products and Waste Materials in Plastics. Synthetic Rubbers and Rubber-Like Materials. Electrical Properties of Plastic Materials. Chemical Properties of Plastic Materials. Optical Properties of Plastics. Styling and Art in Plastics.

★

NO pleasure driving—no bright lights downtown—you'll be home a lot this year, especially in the evenings. Instead of the monotony of extra time at home, lots of farsighted folks are making spare time hours pay dividends. They're investing evening hours in a plastics education—preparing for the future when *more* technical knowledge of plastics will be important to their career in this field.

The unusual Home Study plan of Plastics Institute is specially prepared to give you a practical education in plastics. A series of fully illustrated lessons parade the whole plastics world across your desk—included are 29 samples of plastics—you learn about materials—their applications, properties and limitations—methods of molding, laminating, fabricating and casting—design—testing—all the fundamental information of the complete engineering course. You also receive Plastics Trends, a fast moving publication on the new in Plastics.

Whether you are now in plastics or plan to enter this growing field—it will pay you to get complete information on the Plastics Institute Home Study lesson assignments. Write today for the new Booklet on "Rich Rewards in Plastics".

Plastics
INDUSTRIES TECHNICAL INSTITUTE

NEW YORK	LOS ANGELES	CHICAGO
1220-A Chanin Bldg.	182 S. Alvarado St.	626-A La Salle-Wacker Bldg.
Dept. 4	Dept. 4	Dept. 4

AMERICA'S ORIGINAL PLASTICS SCHOOLS

Francis A. Gudger, President
John Delmonte, Technical Director

ADVISORY BOARD

E. F. Lougee, Chairman

Donald Dew, Diemolding Corporation
Dr. Gordon M. Kline, National Bureau of Standards
Spencer E. Palmer, Tennessee Eastman Corp.
Louis M. Rossi, Bakelite Corporation

MIDLAND DOES IT...
Especially on precision thread milling

★ **Precision requirements of plastic molding are nothing new to Midland, but war-time emphasis on speed plus accuracy have given us an opportunity to demonstrate our ability to do the unusual. We are now supplying many molders with core pins, as shown above, used in molds for M. 52 fuses, and having milled threads held to tolerances of .0001 on a production basis. ¶ Experience and skill, plus precision machinery and optical measuring equipment, enable Midland to meet the most exacting requirements of war or peace-time manufacturing in plastic dies and molds, hobbed cavities, engraved parts or steel stamps.**

MIDLAND DIE AND ENGRAVING COMPANY
1800 W. BERENICE AVENUE • • • CHICAGO, ILLINOIS
Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving

LOW SURFACE CREEPAGE
+
LOW MOISTURE ABSORPTION
+
HIGH ARC RESISTANCE
+
HIGH DIELECTRIC STRENGTH

Combine to Make MELMAC
The Best Available Plastic For Many Electrical Applications

Add to these characteristics, the fast, economical mass production of MELMAC* parts by either compression or transfer molding methods and it's easy to understand why this comparatively new plastic is being used in such important applications as aircraft engine ignition assemblies, parts and housings for other vital electrical equipment.

There are several types of MELMAC available which offer unique combinations of dielectric properties that suggest MELMAC's use for circuit breaker housings, terminal blocks, switch plates and similar applications in the electrical field. Write us today for full information on this new plastic developed in Cyanamid's Research Laboratories.

If you'd like a sample molded piece to perform your own tests we will gladly supply as many as you need.

Booster coil housing for aircraft engine ignition assembly is molded of Melmac. In this application high dielectric strength and low surface creepage are important electrical characteristics.

AMERICAN CYANAMID COMPANY
Plastics Division
30 Rockefeller Plaza • New York, N. Y.

*Reg. U. S. Pat. Off.

BEETLE • MELMAC
CYANAMID PLASTICS

MODERN PLASTICS

APRIL 1943 VOLUME 20 NUMBER 8

ASSOCIATED PRESS PHOTO

Bushmaster troops of the Caribbean Defense Command ford a jungle stream with guns and helmet-covered heads held high

Wind-up of the helmet

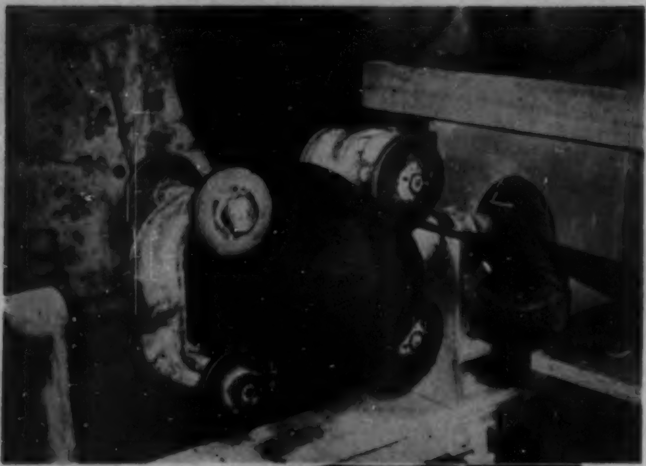
A third method of producing the Army helmet liner suggests a new technique for low-cost molding of small quantities of high-strength irregular shapes from impregnated fabric

ONE of the first "rush" jobs assigned to the Quartermaster Corps when the United States began in 1941 to enlarge its Army by Selective Service was the production of newly designed double-duty headgear—a deep, pot-shaped helmet consisting of a steel outer shell with a lightweight liner for ordinary field service. The liner was the chief problem. Experimentation pointed to plastics in order to obtain a strong, serviceable piece; and with the aid of the research done by the Organic Plastics Section of the National Bureau of Standards and the activity of the plastics industry itself, sturdy plastic liners came off the production line less than six months after Pearl Harbor.* These first helmet liners were molded of impregnated duck by a low-pressure method which permitted rapid production. By early fall of 1942, numerous other contractors were in full swing producing the liners from a phenolic-laminated canvas material under heat and high pressure.†

* MODERN PLASTICS *19*, 35 (May 1942).
† MODERN PLASTICS *20*, 53 (Nov. 1942).

While all this was going on, a New England manufacturer was experimenting with a low-cost technique designed to produce helmets as simply as possible, using inexpensive molds which incorporated a minimum of steel and critical materials, and at small out'ay for equipment in a limited floor space. The construction planned was a medium pressure liner made with resin-impregnated, 4-oz., high-count cotton sheeting (instead of duck, urgently needed for many other purposes).

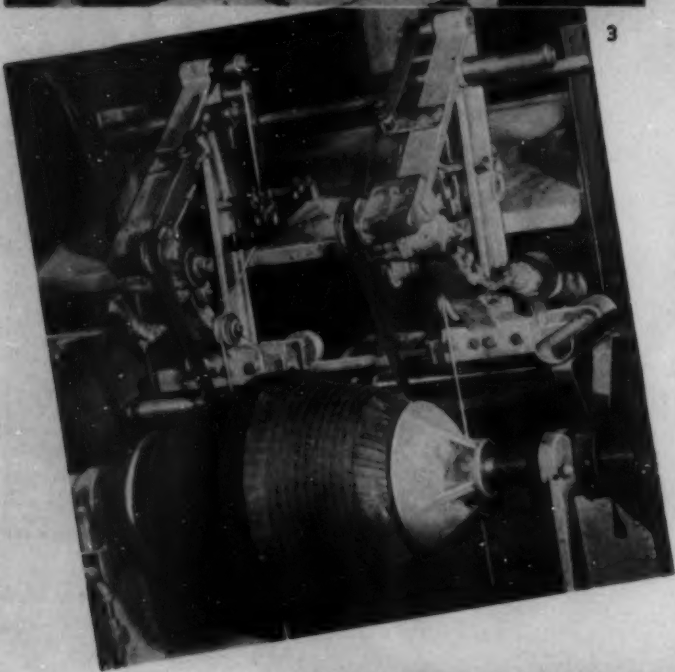
The process was developed entirely from the standpoint of an economical use of construction materials, fabrics and resins. It involves, basically, winding impregnated ribbons around a preform shell to reduce waste of fabric and resin, then molding the shell over a rubber bag in small presses. Anticipating labor trends, the entire equipment was planned for women workers and, in fact, the production unit actually turned out to be 99 percent female operated. After eight months of experimental work, the samples were approved and production started. *(Please turn to next page)*



2

ALL PHOTOS, COURTESY HOOD RUBBER CO.

1



3

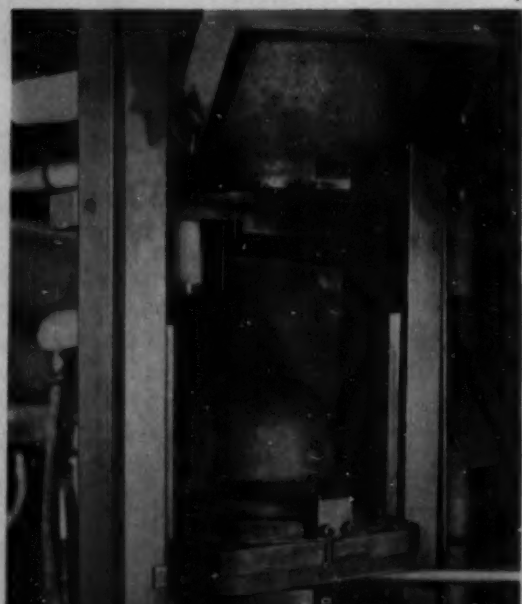
Method of production

The helmet material consists of 54 percent cotton and 46 percent resin. The 4-oz., 40-in. cotton sheeting is impregnated with a quick-drying, heat-and water-resistant, fast-curing resin on saturated spreader rolls similar to those used for laminating. The impregnated sheet is passed through a dryer where it is heated slightly to advance the resin to the desired volatile content and flow characteristics needed for later curing. The impregnated yard goods are then cut into long ribbons 2 in. and $^3/_4$ in. wide on a Cameron slitter and wound onto spools (Fig. 1).

Throughout this and succeeding operations the material is carefully handled, and conditioned as to moisture content and other characteristics necessary for uniform molding.

The ball-winding process was the inspiration for the winding technique which is the initial operation in this method of making the Army "hat." The ribbons are wound longitudinally around an egg-shaped heated mandrel, actually like a

4



5

1—Helmet liners are produced at a saving of more than 15 percent by the machine wrap preform method. Here impregnated fabric is cut on a slitting machine. 2—Ribbons are automatically wound around a heated hollow oval mandrel. 3—The wrapped "watermelon" prior to cross winding, after which it is cut in half. 4—A rubber bag over a cast iron dome acts as the force plug over which the liner is placed. 5—Preform ready for molding

huge watermelon in appearance (Fig. 2). These mandrels are formed of two hollow metal halves (approximate weight, 10 to 12 lb.) held together by a thin steel band in the center. The mandrels are heated in 160° F. ovens and then dusted with talcum to prevent sticking. The 2-in. ribbons are automatically wound around the entire melon in about 20 sec. after which the latter is ready for its second winding. Figure 3 shows the narrow $^3/_4$-in. impregnated ribbons being wound around horizontally to form the lower half and brim portion of the helmet. This cross wrapping increases the strength of the helmet because it forms an extra thick web. Preforms prepared in this manner can be controlled as regards weight because the number of wraps on the egg-shaped form are regulated within a small degree of variation by an automatic speed gun and counting device. Closer wraps obviously produce greater strength for other types of production.

The fabric melon thus produced is then cut into two halves—each a helmet preform. The preform edges are then trimmed slightly to avoid raw edges in molding. (The scrap thus obtained, while not now available, is suitable at this stage for grinding into materials for molded-macerated products.) After trimming, the helmets are weighed as a check on the accuracy of the automatically controlled wrapping machine. Following trimming, a brim collar, which consists of three die-cut strips of 1.60 enamel duck bond, stapled together, is slipped over the edge of the wrapped form. This is designed for extra strength, but it is not considered essential. An important reinforcement is a $3\,^1/_2$-in. disk cut from the impregnated sheet which is used as a crown patch for extra strength at the top of the hat. This is placed directly in the mold before the preformed helmet is placed in the press.

Before molding, the wrapped helmet is placed in a cold press for a 10-sec. premolding operation which smoothes or irons down the ribbons into a compact shape which prevents blisters in the finished job.

Instead of using a standard hydraulic press, this company has manufactured several inexpensive steel frames. A fixed platform is bolted to the top of these frames and a movable platform rides between the frame members at the lower end. This movable platform is actuated by means of a small air cylinder, the purpose of which is merely to raise and lower the platform. The cavity or female portion of the mold, cored for steam heating, is permanently mounted on the upper

6

7

8

9

6—Smoothly finished helmet liner is released from the mold by air. 7—A minimum of trimming is required (just 5/8 in. from the rim), saving fabric and resin. 8—Two machines, punching 6 holes each, prepare liner for its fittings. 9—Suspension harnesses are rapidly riveted in

platform. No elaborate machined steel dies are employed. This cavity is merely a rough cast-iron shape approximating the outside of the helmet liner. In order to gain a smooth molding surface, a $^1/_{16}$-in. thickness of steel is hobbed to the shape of the liner, chrome-plated in order to achieve a high finish on the completed piece and then inserted in and bonded to the cast cavity. All female mold parts are pressed from one master steel die and ring and are therefore exactly alike, which prevents variations in the strict tolerances required which often occur when machining duplicate molds. These molds are comparatively inexpensive, since the initial outlay for the original machined hard steel die is the only costly item in the manufacturing budget.

The force plug of the mold is also a rough casting somewhat smaller in size than the inside of the helmet liner. Over the top of this cast force plug a rubber bag is placed (Fig. 4). This rubber bag is from $^1/_4$ to $^3/_8$ in. thick and has a heavy flange all the way around the bottom edge. This flange rests on the lower assembly platform and is held tightly in place by means of gland and Allen set screws. Both the force plug and the upper mold cavity are cored for steam, which is kept at about 120-lb. pressure.

The molding operation is as follows: the preformed helmet is placed over the rubber bag which has previously been soaped with a special solution to prevent sticking (Fig. 5). The small air hoist raises the lower platform until the entire mold is closed, but at no time does it exert any great amount of pressure. The lower platform is then locked in its position by means of a swivel base and lever. In order to gain the pressure which is necessary in the molding operation, water under a pressure of approximately 250 p.s.i. is permitted to flow between the cast force plug and the rubber bag. Heat is transferred from the steam-heated force plug to the water, which in turn passes it along to the helmet liner. After a curing cycle of approximately 6 min., the pressure is released from the rubber bag and the lower platform is dropped, permitting the helmet liner to be blown from the rubber bag. Molds are changed in about 1 min., thus allowing the entire operation to be performed in about 7 minutes. Thus one girl can easily manage 7 presses. Due to the excessive heat, the rubber bags do not stand up indefinitely but are good for a production of approximately 125 liners. This production capacity is gradually being increased and the company anticipates a much higher production in the near future.

The molded helmet liner is released by blown air (Fig. 6) and is then trimmed on a 3-way cutter (Fig. 7). It is necessary to trim only $^5/_8$ in. of material from the helmet, as compared to the procedure in high pressure methods of molding, where about 1 or 2 in. of material is cut away. This consequent saving of both resin and fabric is one of the chief advantages of using the wrapped preform.

After trimming, edges are buffed and burnished. The helmet is then ready for the punching machines (Fig. 8) which punch 6 holes simultaneously (12 in all): 1 for the eyelet insignia, 3 for the body neck band, 2 for the garter studs which attach the chin strap and 6 for the suspension harness. Figure 9 shows the machine for riveting the suspension onto the helmet and Fig. 10 the suspension in place.

Prior to spraying, the helmet is wiped with an abrasive and a solvent to remove all finger marks and other superficial blemishes which might cause an imperfect adhesion of the paint. A non-glare, walnut shell flour-filled compound is used which provides a dull, pebbly, non-reflecting surface. Helmets are set on individual revolving spindles in a conveyor unit (Fig. 11) which carries them to the spray booth and on through a battery of infrared (*Please turn to page 152*)


10


11

10—***Looking into the helmet liner, which has suspension in position. Chin strap and neck band are added after helmet is sprayed.*** **11**—***A moving belt carries the liners through the spray booth and under a battery of infrared lamps where they are dried to a dull, glare-free finish***

PHOTOS, COURTESY ALUMINUM CO. OF AMERICA

1

2

1—Forged aluminum spinning buckets used in the rayon industry (left) are rendered corrosion-resistant by a heavy coating of phenolic resin in solution (right). The spinning spool (center) is similarly coated. 2—Mine waters will not affect aluminum pipe coated inside and out with phenolic. At right, halved sections of plastic-coated condenser tubing

A new partnership is formed

Intelligent teamwork widens the field for both aluminum and plastics, and many postwar applications of these two materials will find them in combination

by CHARLES BRAGLIO*

SINCE no single material possesses all the characteristics needed to meet every problem of design, it is evident that tomorrow's designing engineers will turn more and more to combinations of materials, utilizing each for its most valuable traits. In fact much work of this type is already under way, and many products now in use do a better job because they incorporate a skillful combination of distinctly different materials.

To the average man on the street, plastics and metals appear to be in highly competitive positions, and it is true that some of the markets once occupied exclusively by the metals are being taken over, at least in part, by the versatile new materials in the plastics group. That this has happened in certain instances in the case of aluminum is a matter of record, but it is also true that these two, when skillfully combined to take advantage of the characteristics of each, are providing new markets for both aluminum and plastics that did not exist for either one alone.

This close teamwork between plastics and aluminum has resulted in some interesting developments in a great many fields. A good deal of the work, of course, is still in experimental stages, but the tangible results obtained to date are most promising.

Spinning buckets

Take an example in the rayon industry. When spinning buckets made of molded plastics were introduced a few years ago, rayon manufacturers breathed a sigh of relief and thought their problems in this direction were at an end. These buckets operate at high speeds in warm acid solutions; and since certain plastics are noted for their resistance to chemical attack, the new buckets were considered the logical answer. But under the stress of increased production, operating speeds were stepped up, and the molded phenolic buckets, which had functioned perfectly at 6000 r.p.m., were found to develop mechanical failures when spun at speeds of 10,000 to 12,000 r.p.m. Makeshift strengthening devices were tried without success, and eventually it was decided to make the buckets out of aluminum, which has an advantage in that, even if small amounts are dissolved, they do not discolor and hence contaminate the product.

After considerable experimentation, a forged aluminum bucket was developed. However, tests in service soon revealed that while this new bucket had adequate mechanical strength and light weight, its usefulness was limited because of the corrosive action of the solutions used in the rayon proc-

3—Heat-conducting aluminum makes excellent cooking utensils. The cook will appreciate the phenolic resin handles, which resist heat and make pot-holders unnecessary

PHOTO, COURTESY DUREZ PLASTICS & CHEMICALS, INC.

3

* Development Division, Aluminum Co. of America.

PHOTO COURTESY ALUMINUM CO. OF AMERICA

4—Powdered coffee for the armed forces comes in packets of moistureproof aluminum foil coated with cellulosic sheet which have been hermetically sealed under heat and pressure. Rough handling and extremes of temperature will not affect these tough little ration containers

esses. Remembering how well the original molded phenolic buckets had withstood corrosion, the designers worked out a type of bucket which combined the best features of both: a forged aluminum bucket with a relatively heavy coating of phenol-formaldehyde resin in solution. So well did the new equipment function that thousands of buckets and spools (see Fig. 1) have been placed in service, and a substantial market for plastics and aluminum has thus been created.

Tubing for mines

In experimental work, the solution of one difficult problem often suggests the answer to other difficulties in perhaps entirely unrelated fields. An outstanding example is the work now being conducted with a view to finding a way for making aluminum tubing useful in handling corrosive mine waters. Since the protective qualities of phenolic resins had already been established by their applications in the rayon industry, it was only natural that the investigators would turn to that industry for help in solving the new problem. Corrosion of metals may be very severe in coal mines, and wrought iron pipe is sometimes eaten through within the space of a few weeks. Therefore sections of aluminum pipe which had been given a heavy protective coating of phenolic resin were placed in a coal mine for practical tests (Fig. 2).

Results obtained have confirmed the belief of the investigators. After more than a year of continuous use, these coated aluminum pipes are giving unimpaired service besides offering the advantage of light weight and ease of handling. Mine operators in many parts of the country are watching the experiment with keenest interest.

Similarly, experimentation is being carried on with this type of coating for a number of different kinds of containers in the food and chemical industries, and it is already agreed that plastic coatings will greatly augment the usefulness of aluminum in this field after the war.

Tubes for creams

A serious corrosion problem was encountered when manufacturers first attempted to pack alkaline creams and tooth pastes in aluminum collapsible tubes. A thin coating of heat-reactive resin solution was applied to the inside of the tube which effectively checked any attack. This timely application of plastics substantially enlarged the field for aluminum collapsible tubes besides opening a new market for plastics.

Plastic coatings may be applied in a variety of ways. Plastics in solution are handled in much the same manner as paint or lacquer, and can be sprayed on, brushed on or applied by dipping. A number of coats can be used, provided, of course, that proper curing intervals are allowed between each coat.

Household equipment

The illustrations discussed to this point have been mainly those involving the use of plastic resins in solution. Some equally interesting uses are possible where plastics in solid form—that is either molded or fabricated—are combined with aluminum. For instance, aluminum is a good conductor of heat, whereas plastics are such poor conductors that they are generally regarded as heat insulating materials. Thus the use of plastic handles for aluminum cooking utensils makes a hot utensil comfortable to hold (Fig. 3). There are a number of instances where industrial tools used under conditions of unusual heat or cold are provided with plastic handles to protect the hands of the operators.

Where special strength or hardness is needed at particular places in complicated articles molded from plastic resins, it is a simple matter to incorporate (*Please turn to page 150*)

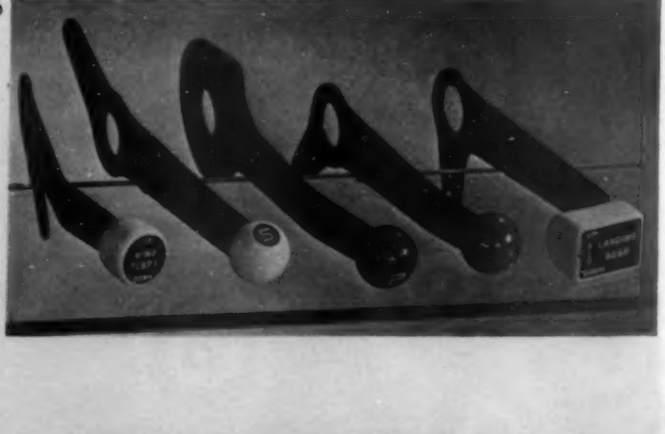
5—Combat aircraft contain numerous parts which combine plastics and aluminum. This acrylic navigator's turret is mounted in aluminum. 6—The plane's aluminum control handles are identified by knobs of colored plastic material

PHOTO, COURTESY GLENN L. MARTIN CO.

5

PHOTO, COURTESY CELANESE CELLULOID CORP.

6



Expendable hypodermic syringe

THE administration of drugs for the emergency treatment of war injuries and shock demands equipment especially designed for maximum convenience, ready availability and speed in use. The difficulties encountered in sterilizing needles and syringes on the field of battle, and the inconveniences involved in transferring injectable solutions from ampule to syringe to patient stimulated development of a convenient and practical unit eliminating such difficulties. Today, the strictest specifications for such equipment are adequately met by the Hypomatic, a new "one shot" automatic injection instrument, which is thrown away after a single use.

This automatic hypodermic syringe (See Fig. 3), a compact unit measuring $4\frac{1}{4}$ in., consists of a sealed, long-necked ampule containing the solution to be injected and an inert gas under approximately 2 atmospheres of pressure. A 2-in. length of narrow, flexible plastic tubing connects the ampule neck with a sterile needle, which is protected from contamination by a removable glass tube fitting over the collar of the needle.

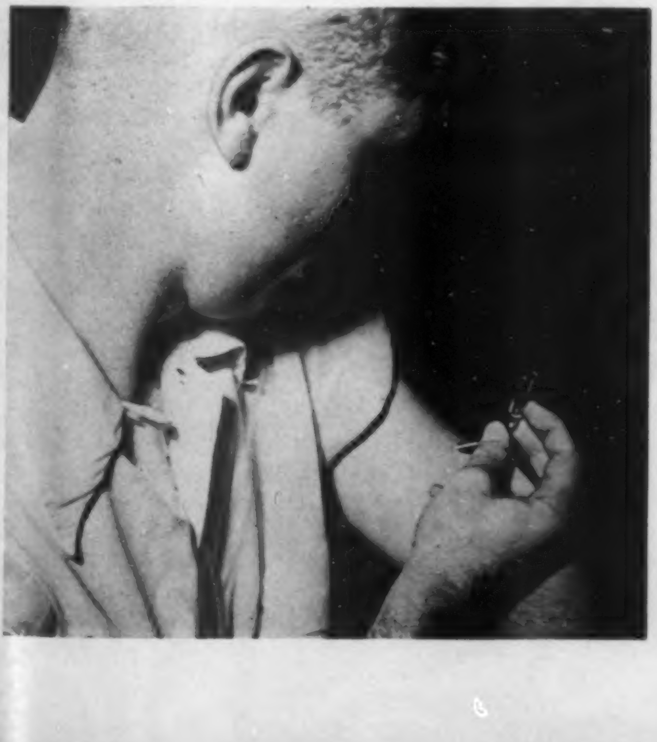
A number of desirable features characterize the small, compact, automatic device. There are no separate parts to be assembled and hence it is ready for instant use. The machine-measured dosage is accurate and not subject to the hazard of human error which occasionally creeps in when time is limited and needs are great. Because injection of the entire contents of the ampule is automatic, no overdose or underdose is possible. The unit is stable at all ordinary temperatures and not affected by changes of atmospheric pressure, which means that it can be used with equal success in airplane or submarine. It contains no metal to become corroded, and the solution comes in contact only with the neutral glass, hence cannot be contaminated. The hypodermic needle is similarly protected.

Injection is made rapidly and simply and, since the entire unit is sterile, sterilization is, of course, unnecessary. The syringe is grasped at the needle base and, after the glass protective tube has been removed, the needle is inserted at the site of injection. Holding the ampule up (thus maintaining the layer of gas above the layer of solution) the ampule neck within the flexible plastic tubing is snapped with the fingers (Fig. 1). The gas pressure expels the solution automatically and the needle is then withdrawn in the usual manner. Particles of glass from the ampule neck are retained by a special filter incorporated in the unit.

The 2-in. extruded flexible plastic tubing used in the syringe (See Fig. 2) is a polyvinyl halide type, containing approximately 45 percent plasticizer, which has been rendered non-toxic. It is highly resistant to abrasion, does not deteriorate with age, is unaffected by (*Please turn to page 134*)

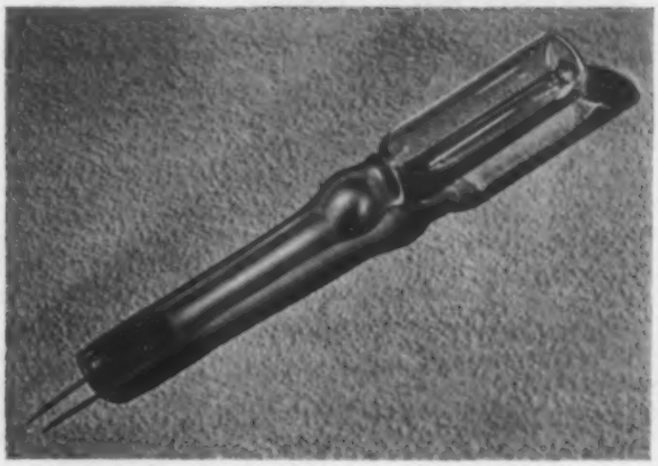
PHOTOS, COURTESY SCHERING CORP.

1



2

3



1—In an emergency, the patient may administer his own automatically injected hypodermic. 2—Flexible plastic tubing permits neck of glass ampule to be snapped off and solution released by a simple flick of the finger. 3—The tiny sterile unit combines syringe, needle, and drug solution, which is kept under pressure of compressed air

Labor standards in the plastics industry

by WILLIAM B. SMITH*

A LAYMAN viewing the growth and wartime importance of the plastics industry is inclined to rub his eyes and ask, "Was it all done with mirrors?" To say "yes" is not a complete answer, of course, but mirrors have played a part—mirrors under the lenses of microscopes, flashing beams of light that ferret out the structure of new plastic compounds which go into the making of vital war materials. Pinch hitting for scarce metals, plastics in many cases have proved superior to the products they replace. This industry, whose very newness gives it a somewhat unique position, can point with pride to its war rôle.

The war output of American industry in general has far exceeded anything thought possible a few years ago, and by comparison with those of 1917–18 present production figures are almost unbelievable. For example, during 1942 we launched 8,000,000 tons of merchant ships, nearly five times the tonnage we built in World War I. Our output of small arms and ammunition is several times as great. None of the 12,089 wood-and-canvas airplanes which we produced in the last great conflict saw front line action. During the year just ended, American plants turned out nearly 48,000 modern planes. The urgency of the hour should not detract from our estimate of present day accomplishment.

Our production techniques are vastly better now, of course, but that does not tell the whole story. There is better direction and a greater measure of cooperation in our war effort today. This is shown by the virtual absence of strikes, and it is reflected in the smooth functioning of some 1800 joint labor-management committees involving more than 3,250,000 workers. Labor standards are higher and employer-employee relationships are much improved.

Among the factors contributing to this result are two Federal statutes that deal with labor standards: the Walsh-Healey Public Contracts Act of 1936 and the Fair Labor Standards Act of 1938, better known as the Wage and Hour Law. The Walsh-Healey Act applies generally to U. S. Government contracts above $10,000. This law sets standards of minimum wages, overtime compensation, child labor and safety and health, and forbids the employment of convict labor in the fulfillment of contracts subject to the Act. The Wage and Hour Law applies to employees engaged in interstate commerce or in the production of goods for interstate commerce. Unless specifically exempted by the Act, such employees must be paid not less than 30 cents an hour and not less than time and one-half their regular rate of pay for all hours worked beyond 40 a week. There is no limitation on the number of hours employees may work—if "overtime begins at 40."

In addition to providing a basic minimum wage of 30 cents an hour, the Fair Labor Standards Act also directs the Administrator to appoint special industry committees for various industries to recommend the highest minimum wage up to 40 cents an hour which will not substantially curtail employment. To date, wage orders based upon such recommendations have fixed minimum wage rates ranging from $32^1/_2$ to 40 cents an hour in some 50 industries.

Recently, L. Metcalfe Walling, Administrator of the combined Wage and Hour and Public Contracts Divisions of the U. S. Department of Labor, set a precedent by appointing a committee for a group of industries, officially called the metal, plastics, machinery, instrument and allied industries. Meeting in New York City on February 16, 1943, this special committee studied existing wage structures and other relevant factors in the various industries. After due deliberation the committee unanimously recommended a minimum wage of 40 cents an hour for the following operations:

"The production of metals and the manufacture of any product or part made of metal or plastics; and the manufacture from any material of machinery, instruments, tools, electrical goods, transportation equipment, and ordnance; provided, however, the definition shall not include:

1. The mining or milling of metalliferous ores.
2. The production of any basic material other than metal.
3. The further processing of any basic material other than metal or plastics; provided, however, that such processing when performed by an establishment producing from such material a product of this industry or subassembly of such product shall be included within this definition.
4. Any product, the manufacture of which is covered by the definition of an industry for which the Administrator has already issued a wage order or appointed an industry committee."

Although this definition embraces a broad field of industrial activity, the component products are closely related to one another in terms of materials, processes, or use. The definition centers primarily around the metals industries and includes all stages of the production of metal products, from smelting and refining to final fabrication. The definition also includes all types of molded, laminated or fabricated plastics products, which have become so important as replacements or alternates for metal products.

The definition covers the manufacture of any product or part made wholly of metal or plastics and also includes any product or part which contains enough of one or both materials to be more logically a part of this industry than any other. Here the determining factors are the relative weight, volume and value of the basic materials, the process of manufacture, and customary trade practices.

However, the definition does not include the assembling of incidental metal or plastic parts with other materials to form a product not otherwise covered. Thus in the manufacture of a glass cooking utensil having a handle attached by a band of metal, only the manufacture of the metal is covered by the definition. The manufacture of the glass parts and the subsequent assembly of the glass and metal parts are excluded. Similarly, the manufacture of plastic rings is included in this definition, but the assembly of such rings with a leather harness is not included.

The definition also *excludes* the manufacture of basic plastic materials in such forms as liquids, powders, pills, flakes, granules, sheets, strips, rods, (*Please turn to page 134*)

* Chief, Magazine Service Section, Information and Compliance Branch, Wage and Hour and Public Contracts Divisions, U. S. Dept. of Labor.

Labels for Leathernecks

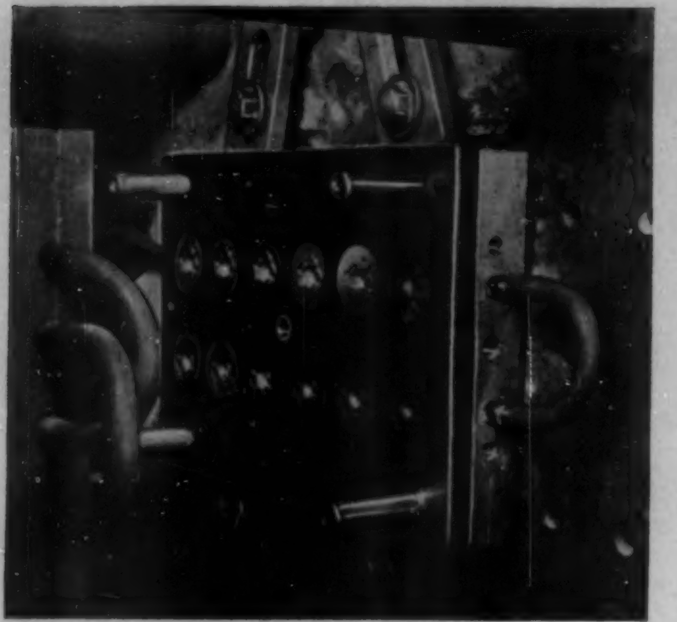
Injection molded plastic insignia now adorn caps and collars of the U. S. Marines, replacing emblems of bronze

PHOTOS, COURTESY TENNESSEE EASTMAN CORP.

Fine design details are molded right into the plastic hat emblems and lapel insignia (top). Backs of insignia show metal shanks. Assembly devices are at bottom. The large washer and nut (in center) are molded as one unit

FROM the Halls of Montezuma to the shores of a Pacific Shangri-La, the annals of the U. S. Marine Corps record an heroic tale of these soldiers of the sea, a story which began with and is a part of the history of the United States of America. Always in the front ranks of the nation's defenders, and proud of the traditions of their branch of the service, the Marine Corps has shown a feeling of unity and remarkable *esprit de corps* ever since its formative years. The function, the scope of activities, the techniques and even the appearance and costume of the Marines have expanded and changed with the years, but the tradition has remained as steadfast as their motto, *Semper fidelis*—always faithful. Even their emblem—the globe (which suggests the breadth of their field of action), the fierce eagle and the anchor—has been a treasured heritage, waving on flags in every port of the world and proudly worn on lace jabots or dusty khaki over the years, whether in silver or bronze, or in plastic as it is today.

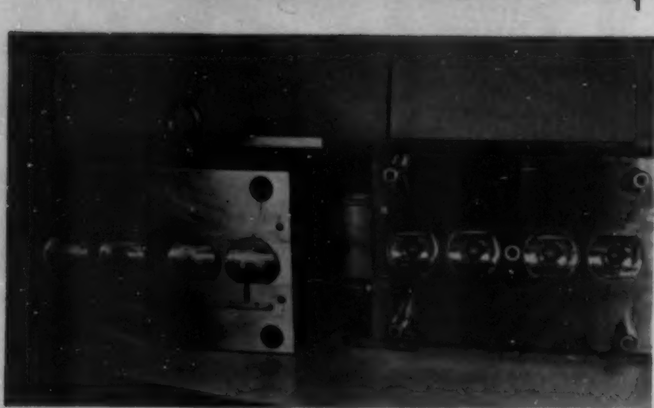
As far back as 1776 the green uniforms of the Continental Marines (formed pursuant to an act passed by the Continental Congress, Nov. 10, 1775) were well supplied with decorative buttons. Officers' were of silver and enlisted men's of durable pewter. After the U. S. Marine Corps was officially established by an Act of Congress on July 11, 1798, and the spectacular uniforms of the Marines began to appear on armed frigates and on the promenades of the new republic, the emblem began to be recognized. Officers wore blue uniforms and red vests. Their red-lined coats were adorned with red cuffs,



1

PHOTOS, COURTESY AMERICAN INSULATOR CORP.

2



3

4

1—Small lapel emblems are injection molded 12 per minute. 2—Complete shot is shown as it is being removed from the mold. 3—Hat emblems are produced in 4-cavity mold in 35-sec. cycle. 4—Metal nut for lapel emblem is assembled automatically. It is set on a revolving chuck and then spun onto the metal shank of the emblem

lapels, sleeve slashings and pocket flaps, and freely sprinkled with bright yellow metal buttons bearing a foul anchor and an American eagle. Enlisted men, too, made use of the emblem on their uniforms (which incidentally called for a black leather stock—inspiration for the nickname "leathernecks").

But the frivolous trappings of the early Marines (largely influenced by the costumes of European military outfits) were no detriment to the auspicious start of this fighting unit. Only a few weeks after its formation, the Marine Corps was thrown into the Revolutionary War, and within the first years of its history, the U. S. Marine Corps established the scope of practically all its future functions. It became then, as it is now, the fighting arm of the naval service, the first line of mobile defense. And as these activities became more clearly defined, the regulations for uniforms were changed to meet the requirements of the times and the duties of the Service. The French influence prevailed after the Civil War until 1892, when a simpler style of dress appeared which had many of the characteristics which mark the smart, streamlined uniform of the 20th century Marine.

In 1868, the Marine Corps officially adopted its present insignia—a hemisphere bearing the map of the Americas, superimposed upon a foul anchor and surmounted by an eagle with spread wings. A deep bronze had been the standard for these insignia until the advent of World War II, when with typical progressiveness, the Marine Corps joined the rest of the nation in its conservation program and decided plastics could provide luster where metal had long shone.

In selecting the new medium, principal consideration was the fact that the material had to withstand the high temperatures and the weather conditions in the tropics, resist moisture, corrosion, deteriorating effect of salt air, and maintain good dimensional stability in all climates. In addition, economical, rapid production was extremely important to meet the needs of speedily expanding Marine personnel. Cellulose acetate butyrate was selected in a color that matched that of the original dull bronze emblem as closely as possible, and injection molding provided the mass production required.

The emblems are made in two sizes. A small size for collar and lapel use is made in both right and left styles. This smaller emblem presented no tooling problem, as the flat back permitted straight hobbing. Twelve-cavity molds are used to produce each of the smaller emblems (left and right). Total weight of these 12 small emblems is approximately 18 grams and each of the molds (*Please turn to page 130*)

The postwar rôle of plastics*

by JOHN DELMONTE†

THE widespread rôle of plastics in the present war program presages an even greater expansion of activities in the years to follow. While all our present programs are focused upon victory in this world struggle, we can with some satisfaction view our present accomplishments in the light of their enduring worth. Such reiterations should inspire us to redouble our efforts when we realize the permanent nature of many of our present gains.

There have been many outstanding accomplishments in plastics during the past two years. It is quite significant that many of these achievements have been marked by the transition of plastics from colorful, decorative applications to industrial purposes. I am not overlooking the numerous mechanical and electrical applications which have been featured in plastics in years past, but during the past year we have changed our evaluation of plastics from terms of color, gem-like qualities and decorative appeal to the more sober aspects of strength, behavior at −70° F. to 180° F., electrical properties at high altitudes and dimensional stability. We have not forgotten the decorative qualities of plastics by any means. These have already proved themselves in the years preceding the war, and in the hands of a new generation of industrial designers will resume their accelerating pace after the war.

Engineers look to plastics

The present need for raw materials and increased production has opened the eyes of engineers and technicians to the possibilities of plastics. For us this is a fortunate circumstance, because formal technical education in the universities today is built chiefly around metals, sometimes around woods, but seldom around plastics. From the fact that engineers and technicians are now weighing the advantages of plastics as well as those of metals and woods we can take some satisfaction, forceful as the circumstances were which brought on the trend. Let us not relax our cooperation with these technical men, however, because it takes more than a few technical bulletins to counteract habits of thinking developed through years of concentration upon metals. I hardly need point out that a table of properties of a new plastic will not necessarily point the way to—let us say—the use of this plastic in some aircraft part. We must encourage engineers and technicians responsible for material developments to reason along the following lines: "Here is a part required for a certain assembly. It can be manufactured from metals, plastics or a combination of both. I will design it in those materials which will give it functional perfection at the lowest cost." This reasoning leads to the use of whichever material does the job better, whereas in the past the trend of thought was one-sided, in favor of metals. From this newly developed attitude we can expect intelligent planning in the years to follow.

Combinations with other materials

In this period of increasing plastics activity we are impressed with the versatility of plastics and the ease with which they lend themselves to combinations with other products. The plastic may in itself appear as the outstanding element in this combination or may in a limited manner contribute to the efficiency of other materials. For example, the small amount of plastic in a plywood structure is less significant than the wood veneers selected for strength. On the other hand, the plastic in the fairing shaped for an aircraft assembly may be more significant than the cloth reinforcement. The combinations of plastics with other materials are growing rapidly and in years to follow will feature many design trends. This activity is largely due to ingenuity displayed by various technicians faced with material shortages.

I am not trying to say that cloth, paper and wood are new to the plastics field. They are not, and are well known in their macerated form in molding compositions. However, in such new activities as low pressure laminating, production methods are designed in accordance with the special physical characteristics of cloth, wood or paper.

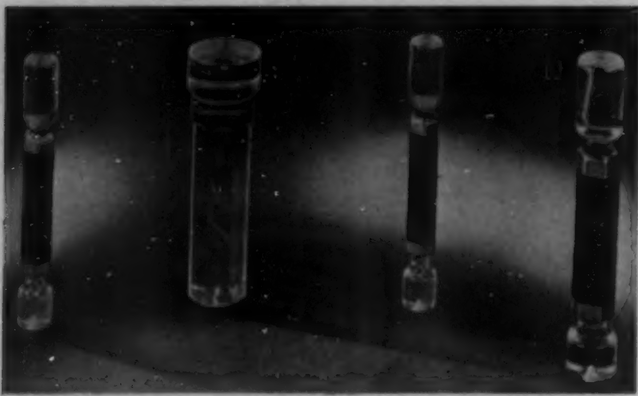
Textiles

Perhaps one clue to the manner in which the textile industry is examining plastics is the editorial space devoted in their trade journals to synthetic fibers. This is suggestive not only of things to come, but also of activities already in practice. Their evaluation of synthetic fibers has passed the primary stage of the how's, where's and why's of plastics and synthetic resins, of differences between thermosetting and thermoplastic materials, etc., and they have reached an advanced stage of interpretative analysis wherein their questions on synthetic fibers are concerned with the peculiar problems of textile manufacturing such as dyeing, twisting, etc. Based upon their own predictions, we can expect in the years to come that most of the raw materials in the textile field will be based upon plastic materials or natural fibers treated with plastics in some manner. The so-called synthetic fibers can, in fact, be controlled in much more uniform manner than fibers of animal or vegetable origin.

However, there are subjects which the textile journals do not treat as yet, such as low pressure laminating, whereby large semi-structural shapes can be built up at low cost without expensive dies through the aid of resin-impregnated cloth. These applications are now appearing prominently in the war program, and will no doubt provide activities in the postwar period. It means that many small fabricators can develop shapes in plastics without costly dies and equipment. Many valuable lessons in low pressure laminating are being learned and we can expect small fabricators to make everything from lamp shades to awnings from textiles and plastics.

From present textile trends we can readily assume that everyone will have some intimate contact with plastic wearing apparel after the war. Among those plastics which appear most promising in this direction, aside from rayon and rayon acetate, are nylon products, vinyon products, aralac materials, saran products, and various protein and natural resin fibers. However, in listing these fibers already known we are speaking quite conservatively. One might also venture to predict some fiber-forming materials (*Please turn to page 142*)

* Paper read before the Pacific Coast conference of the Society of the Plastics Industry, Los Angeles, Feb. 23.
† Technical Director, Plastics Industries Technical Institute.



Plug gage handles

The unrelenting efforts of industry to utilize every possible opportunity for the replacement of metal often results in the discovery that the substitute material has distinct advantages over the old. In the case at hand, glass and plastics have trod together the road of success.

The glass plug gage, produced by a new method of grinding and lapping a hardened process glass, has demonstrated durability greater than steel and, having a smaller coefficient of expansion, it is more accurate. It doesn't need to be packed in grease to prevent corrosion.

The plastic handles into which the "go" and "no-go" ends of the glass plug gages fit are made in six standard sizes in strict accordance with United States Bureau of Standards specifications. They are injection molded of cellulose acetate butyrate, a compound offering dimensional stability, high impact strength and good welding qualities within the molded piece. Their weight is about $^1/_3$ that of aluminum, which—abetted by an agreeable gripping surface—reduces fatigue in long, continuous use and makes for greater efficiency. Since the plastic handle is a poor conductor of heat, there is little or no danger that the heat from the workman's hands will interfere with the accuracy of the gage.

Credits—Material: Tenite II. Injection molded by Federal Tool Corp. for Langlois Gauge Co.

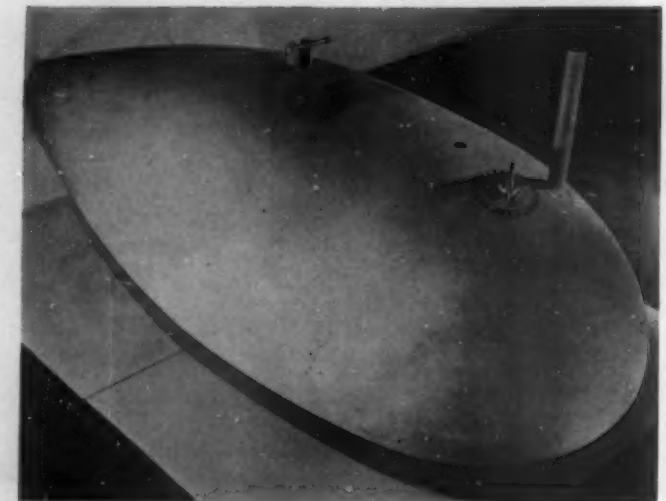
★ PRODUCT DEVELOPMENT ★

Jettison gas tank

On the principle of the camel's digestive system, which provides a reserve storage room for food, a man-made reserve of fuel has been provided the airplane pilot which enables him to extend his flying hours. Supplementing the fuel lines of planes in combat flying, and increasing the range of aircraft in ferry service, various types of auxiliary airplane gasoline tanks have been developed which may be dropped as soon as their fuel supply is exhausted, enabling the pilot to switch to his regular supply without interrupting the flow of gasoline to his engine. They are designed to fit under wings and fuselage.

Shaped like a long egg to minimize wind drag, and an almost perfect example of monocoque construction, the tank pictured is molded of wood bonded under heat and fluid pressure. The stiffness of the skin makes unnecessary any stringers or strengtheners other than three bulkheads. Tests demanded that it withstand more than ten times its weight when filled, or two tons, as a safety factor.

Engineering problems involved the patterning of veneers to make the tank leakproof, the construction of wooden molds around which the thin strips of the bonded veneer are laminated and the necessity for balanced baffles to check



sloshing of the fuel. These had to be worked out with the thinnest possible shell commensurate with the load. A special slush was developed as a coating or inside finish to withstand the chemical reactions of high test gasoline.

Credits—Tank developed by Vidal Research Corp.

Cast drill jigs

War worker and plant manager alike approve of plastic drill jigs. They're lighter than metal, sturdy and comparatively easy to machine. The jig shown at top was used in the production of the aerial delivery container of the Curtiss Caravan and was made of a liquid phenolic casting resin. Similar units save tooling, do not require an expert tool maker; in cases like this a special pattern is not needed.

The jig was made directly on one of the containers, assuring perfect contour. The cross bar is for reenforcement and guide. Holes for bushing locating pins were drilled in the resin (which in its cured state has about the same consistency as hard maple wood) and the bushings were cemented in place with a low-melting alloy which expands when it solidifies. The resin has an impact strength of 0.11 to 0.15 ft.-lb. (Izod); a compressive strength in excess of 20,000 p.s.i.; and flexural strength from 7000 to 9000 p.s.i. Shrinkage is .003 in. after a two-hour bake at 140° F.

The aerial delivery container (below) for which the jig was used is of a phenolic-bonded plywood molded in an autoclave. It is light in weight, sturdy, with a smooth surface free of fastening rivets, and weatherproof.

Credits—Material: Durez casting resin. Molded by Aviation Engineering, Inc. Container, Durez bonded plywood by Allied Aviation, Inc.

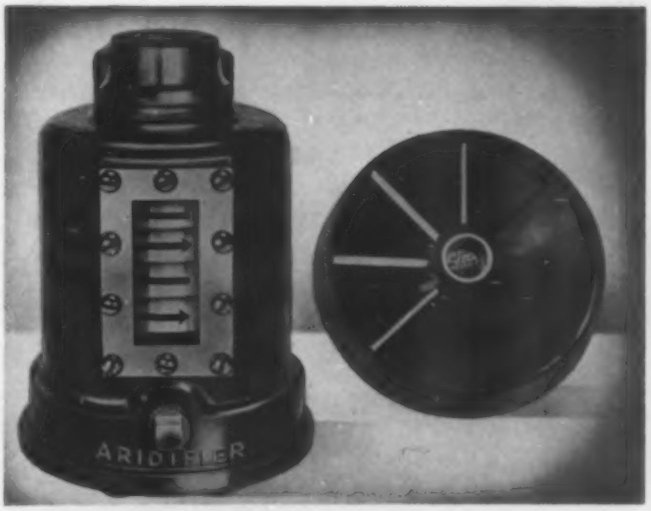
★ PRODUCT DEVELOPMENT ★

Rotors for aridifiers

Condensed moisture, oil, rust and other foreign matter almost invariably accumulate in compressed air and gas lines. To eliminate the corrosion, clogging and premature wear which these elements cause, an aridifier installed at the proper point will usually prove effective.

One such machine consists of a substantial cast housing enclosing four molded phenolic multi-blade rotors driven by the air in the line, indicated by black arrows in the photograph. These rotors, mounted on a vertical shaft which is concentric with the air inlet at the bottom and the air outlet at the top of the unit, are the heart of the aridifier. The vanes in each rotor are inclined (right) and revolve at high speed, each in the opposite direction from those adjacent. The dirt impinges on the blades and is thrown by centrifugal force against the housing wall, falls downward into a trap.

Until recently the rotors, subject to constant wear and abuse, were made of aluminum. However, the need for a replacement material caused the manufacturer to study a similar machine being tested in England whose rotors of molded phenol-formaldehyde were reported to be successful. They could be pre-balanced without the slow, costly and tedious operations required of metals, and machining and other



operations were claimed to have been reduced 58 percent through the use of plastics. The plastic rotor weighs 1/3 less than the aluminum rotor.

Credits—Material: Bakelite. Molded by Chicago Molded Products Corp. for Logan Engineering Company

1

1—Ignominiously hauled by tractors to the take-off point, gliders line up in orderly rows, waiting to be inducted into service. 2—Hooked up to Army planes, they soar off to glider depots, proud units of the Army Air Forces

ALL PHOTOS COURTESY FORD MOTOR CO.

2

Gliders from the Wolverine State

Special talents of the plastics, automotive and furniture industries find common ground in Midwest production of plastic-bonded plywood gliders

A GRAND Rapids company pioneered in the use of resinous adhesives in aircraft construction. A Grand Rapids pool of 15 leading furniture manufacturers was the first to use the new plywoods in mass production of glider and aircraft structures. And now the Ford Motor Co. has converted an entire factory to the construction of huge troop-carrying gliders and is turning them out, ready for action, at a rapid clip.

Both Ford and Grand Rapids Industries, Inc.—as the pool of furniture manufacturers is known—use the new resinous glues which were made commercially available in the 1930's, and first proved in practice by—among others—the Haskelite Manufacturing Co., of Grand Rapids.

The latter company's experience in lamination and molding of plywood goes back beyond the first World War. They are credited with development of the blood albumin glues which held together the "flying crates" of that war, and in all the years since have championed the cause of plywood planes while all eyes were on metal.

Actually, of course, plywood airplanes are nothing new. When aviation graduated from the stick-and-fabric machines of the Wright brothers, the first material tried for wings was a form of plywood. Lockheed and others were manufacturing plywood planes after the last war. Many famous airplanes, including the *Winnie Mae* which carried Post and Gatty on a trail-blazing flight around the world, were all-wood planes.

But the early plywoods and laminated woods, using albumin and casein cold-set glues, were susceptible to warpage and fungus growth. When the civilian aircraft industry

3

4

swung completely over to the all-metal plane, following the success of the Ford tri-motor, the United States armed forces went along; and until the metal shortage became critical with America's entry into World War II, little attention was paid to wood construction.

In 1938, attention was briefly focused on aircraft possibilities in the newer molded plywoods when an experimental plane was brought out by Clark Aircraft Corp. with a plywood fuselage which had been molded complete in two hours.[1] The Army Air Forces observed the tests of this plane, and conceded the practicability of plywood parts for light trainer planes; but bearing in mind the instability shown by wood-and-fabric planes in France in 1918, they could see little possibility of using plywood in combat service.

Since successful resinous glues for plywood had been put on the market, and hot pressing, molding and impregnating processes had been developed by the time that substitution for metals in aircraft had suddenly become imperative, there was no longer any question of there being a large field for plywoods in military aircraft. The resin-bonded, or plastic-plywoods, were found to be resistant to warping, fungus and salt spray. Quickly established in the rapid mass production of trainer planes, they also provided the obvious answer when the Germans at Crete proved the rôle of gliders in modern warfare and plunged the United States into a tremendous glider-building program.[2] Constantly improved formulas of the resinous glues which make this possible have reduced to a fraction the setting time required and thus permitted such true assembly-line production as that now going forward in the new Ford plant at Iron Mountain, Michigan.

Iron Mountain

The Iron Mountain plant, in a community with a long woodworking tradition, is having its second renaissance. Originally it built wood structures for the early automobile bodies. When the all-metal body came along it went into eclipse, and was revived only in recent years to build wood bodies for station wagons. This activity came to a dead halt with the cessation of automobile production a year ago; and until the glider contract came along some months ago the town's thousands of skilled woodworkers were again idle. Today the glider assembly system spreads through the buildings of the Iron Mountain plant like the fingers of an open hand. The thumb is Building One, where the tubular steel fuselage skeletal structure is equipped with fairing, where fabric is doped and painted and gliders finally assembled. Three fingers represent Building Three, where outboard and inboard wings, floors, fairing, dorsal fins, ailerons, skins, rudders and fins, doors, door frames, elevators and stabilizer are made and assembled. The little finger hooks into Building Two, where the huge shipping crates are made.

The Ford glider is built to a basic Waco design, and is essentially the same as those being constructed at Grand Rapids and in Eastern plants. Approximately the size of a two-motored medium bomber, the glider weighs only 3500 lb., yet has a wingspread of 83 ft. 8 in. and a fuselage that sweeps out 48 ft. 2 $^{9}/_{16}$ inches. It will carry 15 fully equipped soldiers or their equivalent in cargo—even a jeep.

Ford is using a mahogany plywood, the standard hot press material made to Specification AN-NN-P-511b. Sealer and varnish are applied to the surface during the process of fabrication to make the wood moisture-resistant. Thus finished, the wood is virtually impervious to the elements and actually stronger, pound for pound, than the thin aluminum sheets customarily used on planes.

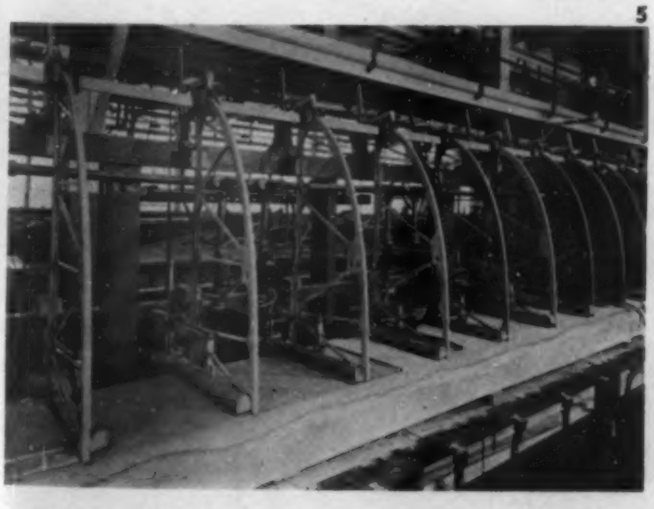
The woodworking job involves the shaping and fitting of spars and struts of airplane spruce, both in the wing sections and in the ailerons. Most of these parts are laminated for extra strength, and here again the resinous plastic glues are used.

Possibly the most important Ford contribution to plywood fabricating technique, however, is the use of steam, piped through an ingenious network of flat rubber "veins," to speed the glue-drying process by the simultaneous application of heat and pressure while the glider parts are held in fixtures. Waste steam from the plant's power house is utilized. Gluing processes which once took 6 to 8 hr. now are finished in less than 10 minutes. No other single develop-

[1] See "Plastics as Structural Materials for Aircraft," G. M. Kline, MODERN PLASTICS *15*, 35 ff. (Aug. 1938). "The Plastic Airplane," MODERN PLASTICS *16*, 41 ff. (Mar. 1939).
[2] See "Hot Wings and Cold Set Resins," MODERN PLASTICS *20*, 52 ff. (Sept. 1942).

3—*At Iron Mountain, steam piped through rubber tubes supplies heat and pressure to speed up glue drying process. On outboard wing assembly line, fixture at right, carrying 10 lb. of steam, is open, showing rubber-tube lining of each rib clamp. Left fixture is closed.* **4**—*Inboard wing skins are assembled in fish-scale formation, and urea resin glue dries in 20 min. under steam application.* **5**—*This inboard wing assembly fixture uses electrical elements in clamping pads.* **6**—*Plywood skin is here placed over floor frame and glued under steam pressure*

5



6

ment has been so important in speeding mass production of finished gliders.

The rubber tubing is ingeniously fitted into fixtures in which the plywood skin is applied to wing and other surfaces. When the tubing is filled with steam it expands and applies both heat and pressure to the desired points. The steam method also is combined with electrical heat by means of jigs and clamps to glue in ribs, stringers, stiffeners and countless other major and minor structural parts. Virtually every essential part of the Ford glider is glued together with the aid of either steam or electricity, or a combination of both.

The movable, shoe-like steel jigs reach into areas which cannot be reached by rubber tubing, firmly clamp the joints and then heat them into a virtually unbreakable union. In one such operation—the joining of wing sections—drying time is reduced from 5 hr. to 30 minutes.

It is possible, however, to employ the steam-bearing rubber in at least 30 percent of the fixtures. Not only does the hot, expanded tubing dry the glue with spectacular speed, but by applying a constant pressure of 10 lb. per sq. in. on the glue-joint areas, irregularities of surface which might mar the plywood skin are smoothed out.

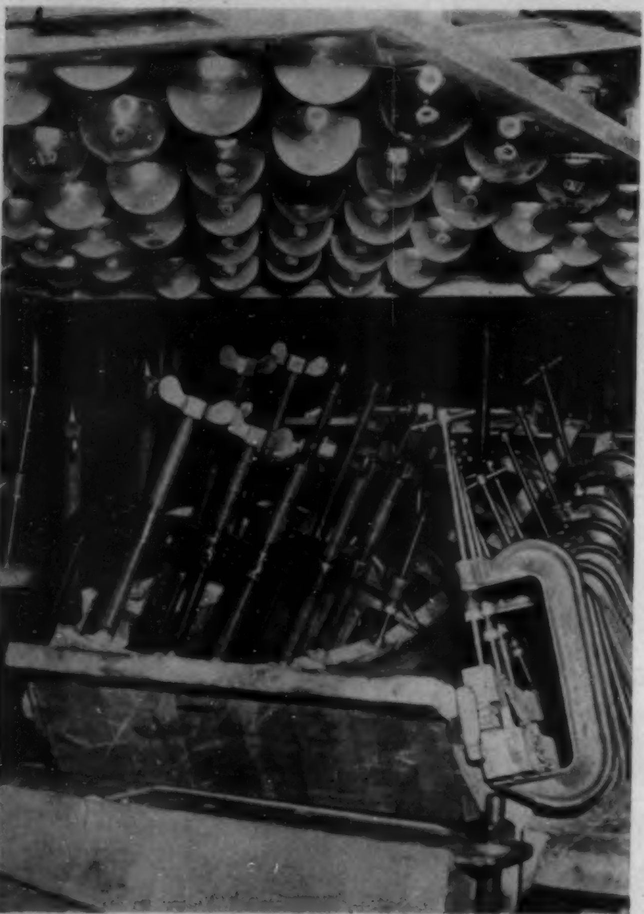
Throughout the entire Iron Mountain plant, practically all plywood gluing operations are stepped up in drying time through utilizing some form of heat application. The nature of this is contingent on the structural components of the assembly to be handled.

In the simpler forms of assembly at the primary stages of operations, such as building up ribs, bulkhead details or other flat assemblies, the parts of an assembly are grouped on flat sheet metal fixtures which are inserted between steam-heated platens of a hydraulic press. These platens carry 220° to 240° F. temperature, which will penetrate $^1/_{16}$-in. thick plywood and dry the glue in 3 minutes. Platen travel is controlled by spacer bars dimensioned about .010 in. less than the combined thickness of the parts being glued. The plates or fixtures holding stock locate the elements as a rule without the use of nails.

The old established procedure in small aircraft construction is to nail the assemblies and air-dry under room temperature, which requires 6 to 8 hours' time. This would be impractical where quantity production is required, unless floor space and labor were of no consideration.

Where assemblies take a form not readily placed between platens, the fixtures are provided with suitable mechanical clamps which in most cases carry the heating element in direct contact with the parts. Where the space does not permit the heating element on the clamp or in the base pad opposite the clamp, infrared lamps are used to provide heat. The average assembly so heated dries in 20 to 25 minutes.

PHOTOS, COURTESY FORD MOTOR CO.



7

8

9

7—Using pressure clamps and batteries of infrared lamps, nose stringer sections of the glider are bent, laminated and dried in a single operation. 8—Overhead monorail conveying system carries glider wings to the painting booths. 9—Operations on the glider's giant rudder assembly are performed in strictly air-conditioned rooms

Where heavy sections are glued, as in wing spar assembly, the drying time is considerably extended and the infrared lamp is considered the most practical heater.

A typical assembly line is the build-up of the inboard wing, which takes the rib assemblies from the platen presses and the front spar from a fixture using infrared lamps over a steam-heated base member. These are assembled to form the wing nose skeleton. The rear cross tie members of the ribs are clamped to the spar with a battery of toggle lever clamps carrying electric heating elements placed inside the clamp pads. These pads range from 225° to 285° F., and drying is accomplished in 20 min.—penetration being through $^1/_4$-in. to $^3/_8$-in. square spruce.

The next operation is gluing on a $^1/_8$-in. plywood skin over the nose frame. Here the pressure and heat transfer are combined by having a rectangular hollow rubber tube as a filter unit imbedded in a channeled seat in the clamping member shaped to follow the contour of the ribs.

The procedure is to place the pre-formed skin over the nose, the ends overlapping the spar for about half its width. The skin is tacked for accurate alignment. The fixture is then clamped to get an initial pressure along and over all the glue surfaces. Steam is then admitted inside the clamping rubber tubing at 10 lb. pressure. Twenty minutes under pressure is sufficient time for drying. The special rectangular rubber tubing used in this type of fixture—and all major assembly fixtures are so equipped—is a development of the Ford Tire Division, based on a heat-resistant rubber formula.

The greatest advantage afforded by this method is that the expansion of rubber allows it to blend into and follow irregular contours. On curved surfaces it is almost impossible to get a full surface contact with metal pads, and without full surface contact it is impossible to count on good glue joints.

In addition to its use on various large assembly fixtures, the rubber tubing handles the skin covering on both sides of the glider floor, an area of 12,474 square inches. Here the operation is allowed 50 min. for drying. This formerly was accomplished by shot bag loading under room temperature in 10 hours.

The entire process, whether lamp, steam or electrical heating units are used, eliminates the objectionable nailing strip heretofore widely used in the aircraft field. These processes, in addition to being faster, have the virtue of not marring the surface of the plywood or weakening it by puncturing the grain.

Building Three, where these operations are carried on, is closely air-conditioned. A huge air-conditioning installation maintains constant temperature of 75° F. and humidity of 55, to avoid distortion during fabrication of the plywood-and-spruce wings, rudders, dorsal fins and noses, and maintain the Government-specified moisture content in the wood. There are large cylindrical humidifiers which atomize steam and whirl it in fine spray above the heads of the workers.

To telescope the manufacturing time, various phases of assembling have been assigned to groups of independent units, exactly as is done in automobile assembly. The completed products of most of these crews move systematically via the overhead conveyor lines, timed exactly to the movement of the main wing assembly line, where sub-assemblies are joined as described above, and plywood skin applied. Other sub-assemblies roll on monorails to the fairing and doping rooms, where they are prepared for final assembly.

To the fairing rooms, which once served as drying kilns, come first the prefabricated steel skeletons of the fuselages. As they arrive in these long corridors, the steel tubing is inspected and then the fairing job is started. Floors, spruce

PHOTOS, COURTESY FORD MOTOR CO.

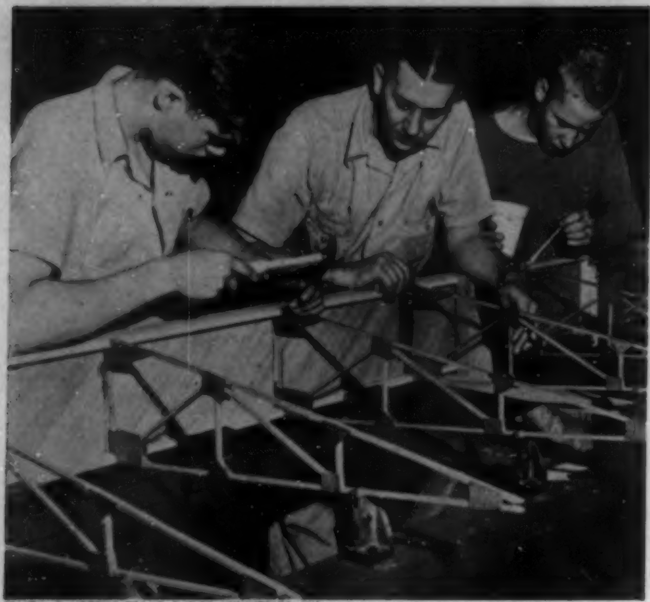
10

11

12

PHOTO, COURTESY GRAND RAPIDS INDUSTRIES, INC.

***10**—A glider's cockpit looks like this. Most of its fittings are of molded plastics. **11**—Each glider has more than a dozen zippered openings which permit easy servicing of its mechanism. **12**—In Grand Rapids plant operated by the furniture pool, men and women work side by side, sewing fabric skin on a glider's wing section*


PHOTO, COURTESY GRAND RAPIDS INDUSTRIES, INC.

13

13—*There is no substitute for hand craftsmanship in the forming of the glider's wing framework from aircraft spruce*

and mahogany plywood cross members, skids, door frames, hardware fittings and other parts are attached, and the fuselage sections move on into the adjoining dope room.

The doping room, to which everything which is to be a part of the glider eventually goes to be coated with cellulosic, weather-proof airplane dope, was in peacetime the varnish room for station wagons. It is an anteroom to the final assembly section. Dominating the dope room are two broad spray booths, in which masked, hooded workers operate. Smaller metal parts are placed on trays and sprayed with paint. Wings roll in and are covered with fabric and dope. Fuselage sections move forward to undergo the same process.

Before fuselage sections are clad in fabric, all sharp corners are covered with cellulose tape. Parts of the tubing also are wrapped in tape. Scalloped to obviate unraveling, the tape serves as a base to which the fabric is anchored when wrapped around the tubing.

Tubing and fairing also are coated in early stages of assembly in the doping room. Rust-resistant green paint is sprayed on the tubing, and the tape is also treated. Two coats of spar varnish are applied to the fairing. On arrival in the doping room, the nose of the fuselage is doped along the plywood skin covering the lower part of the front, with two coats being applied. The fabric is then fitted on and held in place temporarily by tacks.

Stretched over the framework, the fabric is then sewn and cemented. It is given two brush coats and one spray coat of clear dope, followed by two spray coats of camouflage. The bottom side of the glider is painted a neutral gray. The final operation in the doping room is the spraying on of the white star of the United States Army Air Forces.

During the various sub-assembly processes, all openings in the fabric are reinforced with cellulose rings and fabric collars. These openings include 12 air vents, 6 on each side of the fuselage. These are capped by plastic "nipples," in each of which there is an underside slot permitting the passage of air.

In the final assembly stages, the 20 major glider sub-assemblies are merged into the broad-winged, completed troop carrier. Joined together are the three sections of the fuselage; 7 empennage parts; 4 wing sections; 2 ailerons; 2 V-struts, and 2 landing gears—one for training, the other for combat. While assembly is going on, pilot equipment is installed in the cockpit and cellulose acetate is fitted into the nose. One of the interesting final operations is the installation of zipper fittings on V-shaped openings cut in the fabric wherever it is necessary to have access to the glider's mechanism for servicing. There are a dozen or more of these zippered openings on each glider.

Completed, the glider is inspected once by Ford inspectors and again by Air Forces representatives. Immediately following approval, the glider is dismantled, and then either fitted into huge specially designed crates for export, or lifted by cranes into long trucks which transport it to Dearborn for flyaway. Brought to the air-frame building at the Ford Dearborn plant, the glider is reassembled, manned by Army pilots and towed away by plane to Army airfields.

Grand Rapids

Production at Grand Rapids was until recently purely on a sub-contract basis, with parts and sub-assemblies being shipped by Grand Rapids Industries, Inc., to the Cessna Aircraft Co., at Wichita, Kan., where the fuselage was constructed and the glider assembled. Recently some complete gliders have been produced at Grand Rapids, but the largest volume is in the flow of parts from the 15 participating furniture factories into the Grand Rapids Industries plant and out again to Wichita. The Cessna glider is built to the same Army specifications as the Waco craft made by Ford, and is almost indistinguishable in appearance.

The Grand Rapids program differs from that of Ford in that it is an achievement in pooling the facilities of a number of small companies and making use primarily of facilities already available, rather than setting up a new, streamlined plant. Consequently, there are many techniques employed on the same type of work. Grand Rapids, however, had an earlier start, and the work has been flowing in large volume for many months. Related to the glider program is the production of similar plywood and wood parts for trainer planes. This work preceded the glider contract and led up to it.

The Grand Rapids and Ford program have in common the use of resinous glues of the type pioneered by Haskelite. Gluing and drying methods in Grand Rapids, however, generally follow the more conventional techniques. Haskelite is now completing a $2,500,000 air-conditioned plant to be devoted entirely to the production of molded plywood. Temperature and humidity here are controlled as closely as in the Ford Iron Mountain plant.

The roster of Grand Rapids Industries is a roll call of the fine-furniture names on which Grand Rapids' fame has been built for generations back—Imperial, Mueller, William A. Berkey, Johnson, Grand Rapids Chair, Johnson-Handley-Johnson, Hekman, Kindle, Murray, Valley City, Widdicomb, Williams-Kimp, John Widdicomb, Baker of Holland and the Nichols & Cox Lumber Co.

The factory of Imperial, largest of this group, is used as the final assembly plant for wings and other sections, and the spars, braces, struts, and other wood parts and minor assemblies all flow into this plant from the 14 other firms. Although early production was carried on with comparatively crude hand methods, the Imperial plant has now been outfitted with special time-saving jigs and fixtures furnished by the Cessna company, and operations there up to the point of final assembly are comparable to those at Iron Mountain.

One large company operating independently in Grand Rapids is the American Seating Co. (*Please turn to page 128*)

Injection-molded tag holders

PHOTOS, COURTESY REMLER CO., LTD., AND TENNESSEE EASTMAN CORP.


1


2


3

IN peacetime, two such distinctly different civilian groups as hunters and fishermen and the workers on the nation's production lines would seem to have very little in common. The first are workers on vacation and the second are workers on the job. In times like these, however, the former group is contributing to the war economy by replenishing the country's overtaxed supplies of meat and fish, and thus may also be considered workers. Another point of similarity between the two groups is the fact that each individual in both categories wears an identifying badge which tells who he is and his particular function in the scheme of things.

It takes countless tons of metal to stamp the innumerable identification card holders pinned to the shirts of war workers and to the headgear of huntsmen and fishermen. So that stocks of metal may be better used to produce the tools of war, the needs of Government and industry have been coupled with the resourcefulness of plastics molders to produce a practical and economical replacement: plastic identification card holders which have proved more satisfactory than the metal ones they replaced.

The State of California's Division of Fish and Game, which formerly supplied metal holders to licensed hunters, now uses plastic, finding the latter not only a suitable replacement but superior in several respects to the metal counterpart as regards cost and practicability. In the Kaiser shipyards where tonnage rolls off ways at unbelievable speed, and in the Marinship yard now building tankers for Uncle Sam, plastic holders are used exclusively. Here and in other war production plants, many of them employing women, the change from metal to plastics identifying mediums has been made throughout the establishment.

In order to supply these tags to war industries, the manufacturer had to gear production to rigid specifications. First requirement was a transparent, durable, non-flammable material which would not break and which, to keep down production costs both for the molder and for the user, had to be molded into a one-piece tag.

Produced in this form the holder presented several advantages for the user. The card containing photograph and other identification data about the war worker could simply be inserted through a slot and sealed in at that point only. There was no need, as with some types of metal holders, to assemble the unit after inserting the tag and then press the parts together. Once the slot was sealed with a specially prepared adhesive, the identification tag could not be removed or substituted, thus (*Please turn to page 132*)

1—*Workers in the Marinship yards wear their identification badges over their hearts. This attractive welder's tag is plainly visible through its molded holder of lightweight, nonflammable cellulose acetate.* 2—*The hunter's waterproof plastic license holder is pinned to his hat. Because both its sides are transparent, his duck hunting stamp is inserted behind the license, can be examined without unpinning the holder.* 3—*Holders are injection molded in 32-cavity die in one operation. An ingenious arrangement of cams, which are a part of the die, serves automatically to withdraw the side cores through the molded slots in the plastic tag holders*

1

2

3

Plastics in Review

1 This airplane seat, designed to provide as much comfort as possible for bombing crews, is molded as a single streamlined unit of plastic-plywood by U. S. Plywood Corp. The edge reinforcements are incorporated in the original molding operations. The seat weighs less than 5 pounds

2 This button must be pulled to start—pushed to stop. Developed for heavy duty interchangeable units by Arrow-Hart & Hegeman Electric Co., it combines the two operations in one button and increases safety. The unit is molded in two sections, button and base, of Durez, selected for its wearing and insulating qualities and attractive appearance

3 Milady can kick up her heels and momentarily forget shoe rationing if she is fortunate enough to have heels covered with scuffless Pyraheel, fabricated from cellulose nitrate plastic and embossed to look like leather. A heel with a crushed kid effect to match the shoe is shown in the picture

4 Toilet tank floats are ready to meet shortages of copper and other metals. This one of Lumarith is molded in two halves and cemented together for Kirkhill, Inc., by Allied Plastics Corp. The compound used is a tough, corrosion-proof plastic which meets strength requirements and which will not dent, corrode or open in the seams as do the copper floats

5 How thick is a hair's breadth? A simple indicator made by Printloid, Inc., measures it to any size you like—in fact, to within .0001 in.—and holds accurately to the required dimensions. It's fabricated from Vinylite sheet, which has good dimensional stability under varied conditions of humidity and temperature. The hairline indicator shown is .00040 in. sheet of this plastic engraved with a fine ink-filled line and mounted in place with screws

6 Heavy duty jobs for vital parts require extra-service materials. Condenser cases for ultimate use of the U. S. Signal Corps are molded of a mica-filled low loss phenolic to enclose capacitators for plate, grid, tank, bypass and coupling functions in transmitters. These materials provide high dielectric and insulation qualities to offset the high radio frequency voltages impressed on the condensers. Construction of the condensers is simple and sturdy. These housings are molded of Resinox and Bakelite in several sizes by Waterbury Button Co. for Sprague Specialties Co. and Solar Mfg. Co.

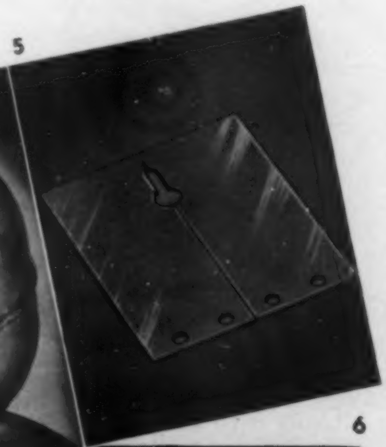
7 Another milestone in the medical world marks the development by the Overly Bio-Chemical Research Foundation, Inc., of an ultracentrifuge rotor of lightweight Lucite which brings the price of this item to within reach of any medical or biological laboratory. The device is used to separate the various parts of liquid bacteria according to their weights. Previous rotors of duralumin would often fly apart, causing considerable danger. The plastic rotors do not crystallize and stresses are distributed

8 Mathematical curves and instruments belong to neat, orderly minds which eschew all but accurate and efficient tools. The items illustrated are made by American Blue Print Co. of dimensionally stable Lumarith and Celluloid sheeting. In addition to the toughness of the transparent plastics, they are easy to clean and pleasant to handle

9 A midget blower which will fit into inaccessible crannies and is completely nonchalant toward temperatures as high as 375° F. is designed by L-R Mfg. Co. for electronic equipment. It measures less than 4 in. in diameter and has an output of 39.5 c.f.m. at 8400 r.p.m., 0 static pressure. The three-piece housing of high impact-resistant Bakelite is molded to close tolerances. Wheel and housing weigh only 4 ounces

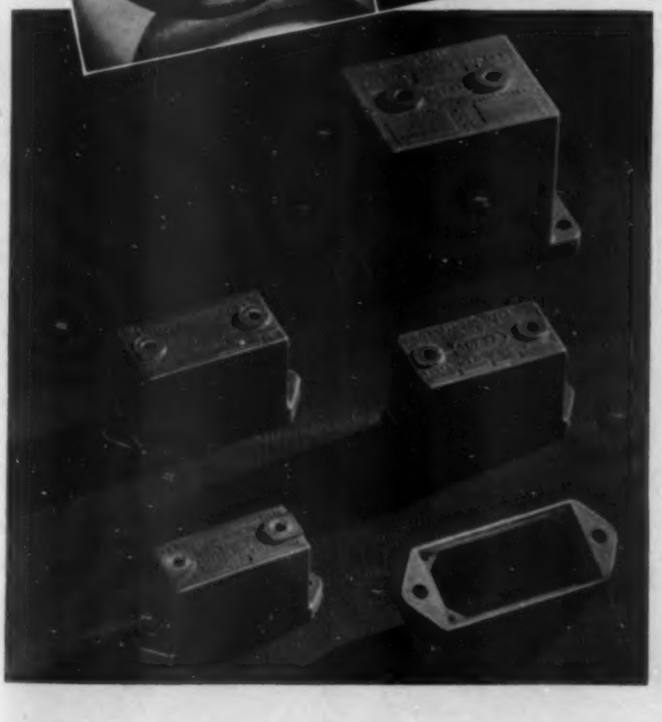
10 A smooth durable handle of molded Durez provides the Dzus fastener driver made by Products Engineering Co. with a firm gripping surface. The material does not react to cold temperatures as do metals, is light in weight and permits the operator to work with maximum efficiency

5

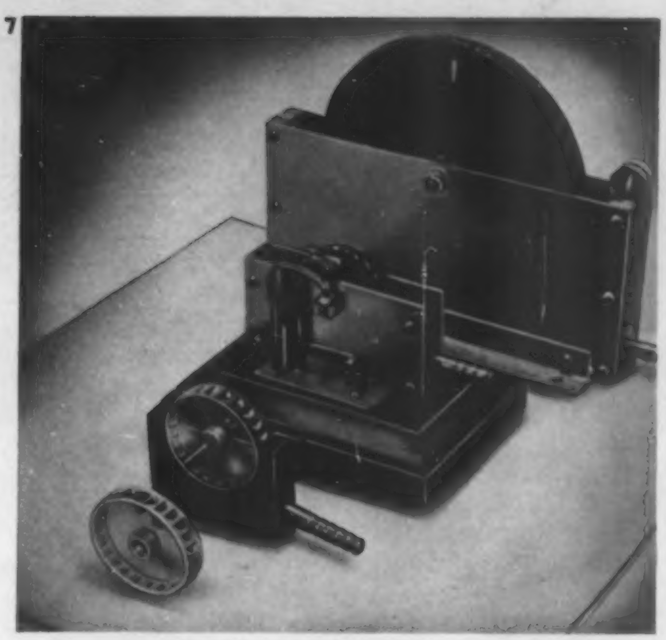


4

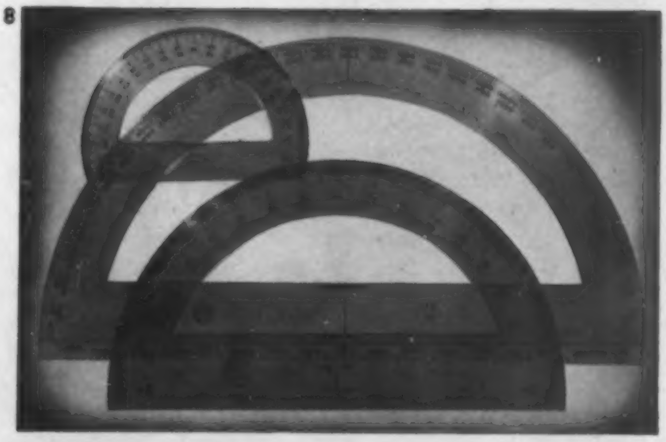
6



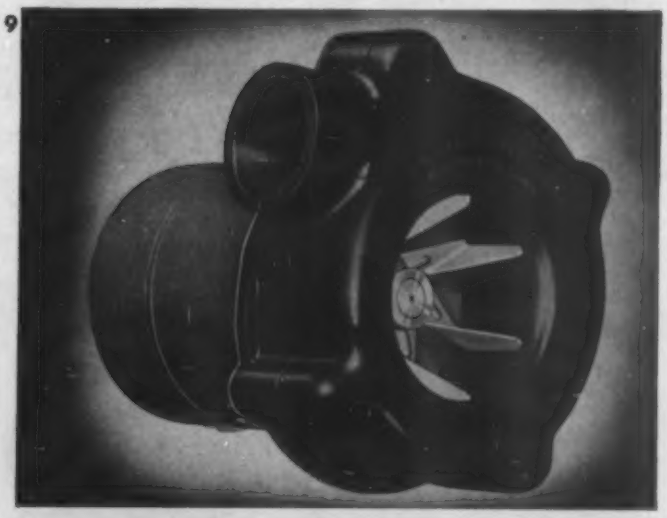
7



8



9



10

A British plan for furniture

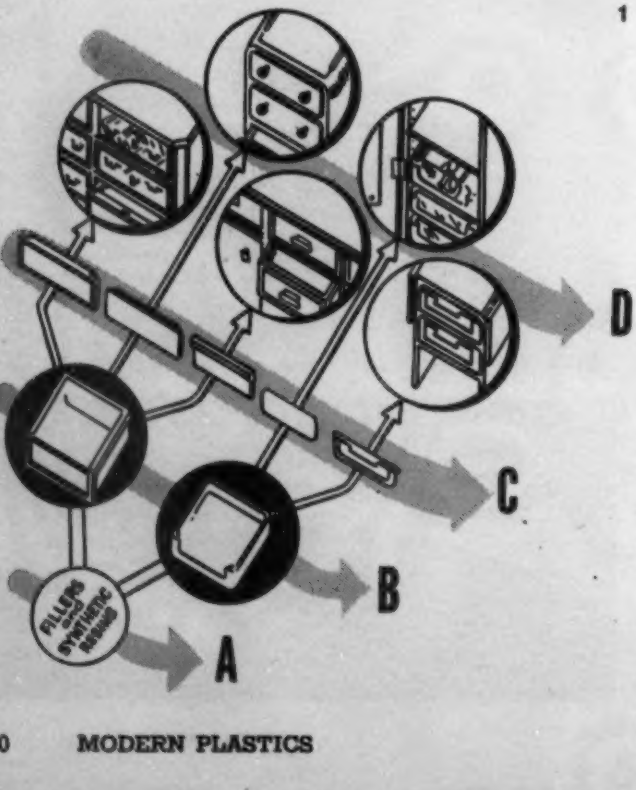
by GEORGE FEJÉR

THERE are several indications to the effect that the conception of interior and furniture design is undergoing certain changes. While it is likely that the furniture of tomorrow will be *different* in design and construction from the customary prewar standards, we cannot be sure whether it will be any *better* until planning work in that connection is sufficiently advanced. Such planning work is already being promoted on both sides of the Atlantic, as it becomes increasingly obvious that the design of interiors forms an organic part of the postwar building problems.

The aim of the present article is to analyze the possibilities of plastics for the production of simple, serviceable and mass-produced furniture units. The writer will not go into the details of the possibilities of "all-plastic" furniture of the de luxe type, and his propositions and suggestions refer mainly to the possibilities of coordinating plastic processes with those of furniture manufacture.

As the furniture makers have become essential suppliers of war materials, and there is no labor, machinery or raw material to spare, the volume of furniture still made is negligible when compared with ordinary peacetime production. This state of affairs is very welcome purely from a technical point of view, because it gives a chance to the furniture manufacturer to get acquainted with new materials and techniques. It also means that certain types of furniture have been discontinued, some of which (we hope) will never return; and thus some of the nonfunctional and hideous types of furniture can die a natural death. The little furniture which is still being made will slowly but gradually be more functionally designed, harder-wearing and more economical to manufacture as the scarcity of raw materials and labor becomes more and more pronounced. The emergency thus will enforce us to make the most intelligent use of what is still available—and there is no harm in keeping up that sound principle even for postwar production.

1



Current requirements

Even in wartime there is still a justified need for housing—and consequently for furniture and interior equipment. Furniture units for hospitals, nurseries, schools, and offices certainly cannot be regarded as entirely unessential, and the usual civilian needs, though severely curtailed, still call for attention in one way or another. In Britain, the Board of Trade exercises control over furniture manufacture, a move which is very promising indeed. It is a kind of control which apparently goes much further than imposing certain restrictions; on the contrary, it has attempted to set up new designs drawn by modern architects and designers. The types projected are simple but pleasing and there will be no fancy decorations or other commercial tricks. From the technical point of view, there is little new in the projected designs, though one point may be worthy of comment here. All sheet material to be used for the paneling of wardrobes, chests, etc., will be of laminated boards, consisting of a $^3/_{16}$-in. hardboard core, veneered on both sides with thin wood veneers. Admittedly there is nothing new in this use of veneered hardboard, as such sheets are commercially available in the U. S., but it is interesting that such sheets have been officially recognized as alternatives for plywood.

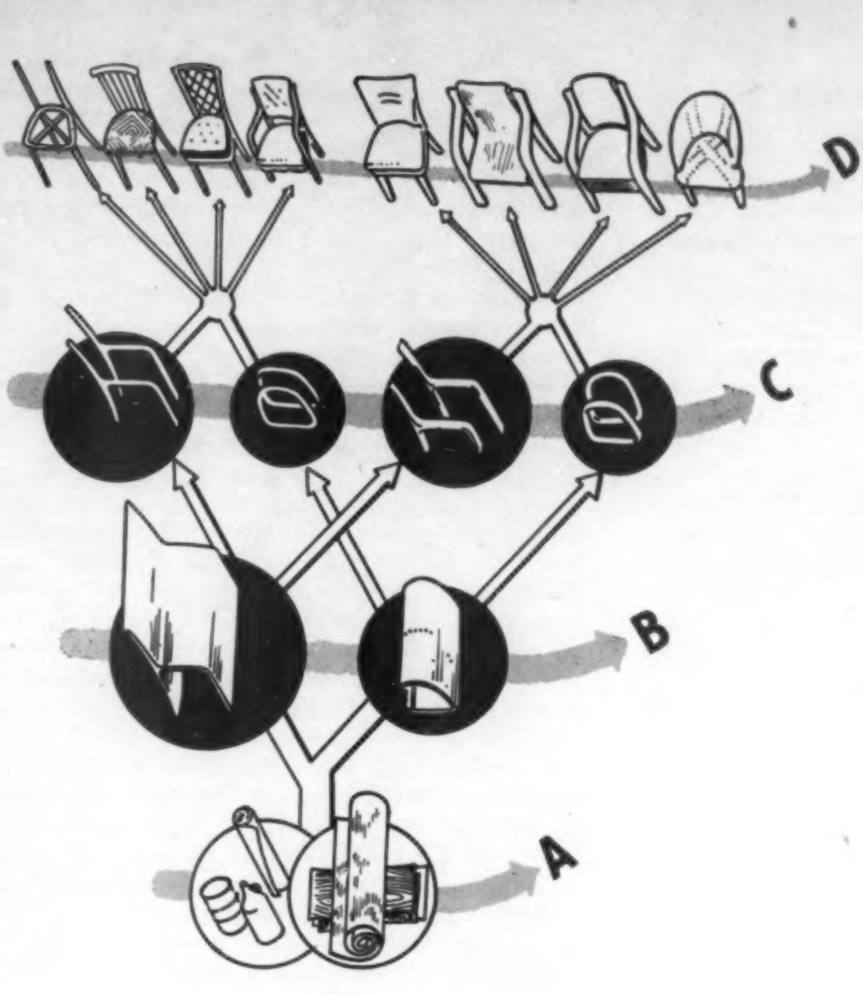
Now from the standpoint of the plastics technicians, the increased use of such laminated structures is certainly of some importance, in view of the fact that plastic sheet material could also produce alternatives for the same purpose. We have already a number of laminated plastic sheets at hand with thermo-hardening plastic surfaces which are equally (if not more) suitable for paneling. It is also an interesting point to note that the "utility furniture" will have no "French polish." This may be regarded as a purely temporary, economic consideration, but it helps to demonstrate to the public that simple, honest, hard-wearing furniture can look all right without high gloss. If plastics can be spared for the purpose, we may not be too far out to foretell that we shall probably see more plastics in utility furniture when it goes into full-scale production, in the form of surface finishes, adhesives, panels and handles.

Past decorative uses of plastics

Examples of the proper use of plastics in interiors are so numerous that they would already fill a fair-sized volume.

1—Progress study for the manufacture of plastic drawer parts. The standardized drawer receptacle (B) can be compression molded of shock-resistant thermosetting resin with fibrous reinforcements, injection molded of plasticized thermoplastic resin, or shaped from sheet material. Drawer fronts (C), of wood, metal, glass or plastic, can be provided by the furniture manufacturer in limitless variety to individualize the finished piece

2



2—Progress study for the manufacture of resin-bonded laminated chairs. Standard frame elements (C) are sawed from shapes formed from resin-bonded wood laminae. The cabinet maker, the upholsterer and the decorator do the rest

The uses of plastics in the interiors of ships, vehicles, bungalows, cinemas, hotels, hospitals, schools, offices, shops, etc., together with their use in purely domestic buildings, already supply a fair amount of experience and show clearly what types of plastics should be developed further. The examples range from refrigerator parts to table-top covering and include practically all the branches of the plastics industry.

Plastic finishing and surface protective materials. Plastics, or materials with high synthetic resin content, have been used successfully to protect the surfaces of wood, metals, etc. Plastic veneers have been used for the decoration as well as the protection of interiors with good effects. We have seen both the urea and phenolic type paper-base veneers in applications where they appear to be superior to other older types of finishing methods. The technique of cementing these veneers on wood, plywood or composite boards can be regarded as a fairly easy one as the initial difficulties in the handling of these plastic sheets have been largely overcome by now. Similarly, the laminated plastic boards can be regarded today as materials which have met with fair amount of success in practice. There are several types of thermosetting resin boards which can be fixed on a rigid framework or parallel joists, etc., in much the same way as hardboards. Surfaces with double curvatures or otherwise intricate design are difficult to protect with veneers but here we have the versatile impregnated fabrics at hand.

Certain thermoplastics such as cellulose derivatives, vinyl polymers and acrylics have already helped to extend the range of the available "leather-cloths," and there are still more to come. The general public does not yet realize that plastics have already modified the paint and varnish technology in many respects, and that certain proportions of thermosetting resins are already being used in oil-type and cellulosic-type finishes. Ureas and melamine resins, compatible with a range of natural resins, alkyds and solvents and paints familiar to the painters and decorators, are already being used a great deal; and these together with the phenolic finishes will surely play an important part in the design of postwar interiors. Obviously the best results can be achieved only if we can use such finishes under perfectly controlled workshop conditions. If we assume that partial prefabrication will provide entirely workshop-made interiors, even for permanent buildings, we may consider the "oven-enameling" with thermosetting resins as a practical proposition. The present tendency to use thermosetting finishes in exactly the same way as older types of finishes may be regarded as an important but still transitional stage in the development.

Rods, tubes and extrusions. So far any advantage that has been achieved in the production of certain plastic laths, trims and cover strips has usually been offset by some new disadvantage when these materials are compared with metal bars. By using the newer resins certain improvements have been achieved; but the pliability and shock-resistant character of plastic laths made of cellulose derivatives, and the heat-resistance and dimensional stability of the thermosetting extrusions are characteristics difficult to combine. There are two ways in which the plastic laths and trims definitely supersede all older types of laths, such as those made of wood or metals: first, by improved electrical properties and, second, by the possibility of doing away with surface protective treatment. Where one or both of these requirements are of the utmost importance, the advantages of plastics

can be exploited to the full, and it is therefore likely that new types of laths, hitherto nonexistent in other materials, will be developed.

Compression and injection molded components. Practically all methods of manufacturing modern plastic materials are being carried out at high speed by using molds of high initial cost (with the exception of casting and thermoplastic shaping techniques). This means that the manufacturer has to produce a large number of replicas in order to make the initial outlay worth while.

Very few people object to having in their homes exactly the same kinds of door handles, curtain rails and other such items as their neighbors have. When it comes to larger components, however, the trouble starts: matters of individual taste and the desire to own something "different" come into the question. There are plenty of woodworking factories, designers and smaller craftsmen who are capable of satisfying variations in taste, and it may be more cautious to keep within certain limits when producing furniture components on a large scale. Units of the kitchens, baths, offices will become standardized down to even smaller numbers of variations, and people do not seem to mind very much about the majority of their possessions being uniform and mass produced; but certainly many would resent having nothing but molded furniture in their living rooms.

Molded drawer parts

Fortunately, there are many parts and components of domestic furniture which can be and will be almost completely standardized without conflicting with the desire for individuality. These components are mostly those which satisfy a certain well-defined need and derive their measurements from the standards of the human body. The measurements of bathroom medicine cabinets, plate racks for the kitchen, and many other things vary only within narrow limits irrespective of geographic or esthetic conditions. Let us analyze only one of these standardizations in more detail, and the possibility of using various plastics in its manufacture.

The writer believes that drawer parts for chests, wardrobes and sideboards can be made from plastics. This idea is illustrated in Fig. 1, which shows two types of molded plastic drawer parts as half-finished articles. These would require that only the front part be made by the furniture manufacturer. These front pieces (*C*) could be made in as many varieties as required by using wood, metal glass or plastic, according to the character of the furniture unit for which the drawer is intended.

The shapes of the molded parts could be standardized down to six or seven, but the front pieces (as these would be made by a smaller scale process) could produce hundreds of variations. There is a justified need for improvements in the customary types of drawer units which are mostly made as a combination of solid wood and plywood. The plastic unit would have rounded corners, and there would be one piece instead of the usual five and no dovetailing. The drawer made of the suitable plastic would probably slide more smoothly, eliminate sticking, and the whole article would be a better finished, tighter fitting and more hygienic job than its traditional counterpart.

It would be dangerous to think, however, that any wood-flour-filled plastic, molded to any hollow shape would automatically be suitable for manufacture by the millions, and that it would oust all wooden drawer units all over the world. It will need much more careful design analysis, as well as application research, to plan the most suitable set of shapes, and to solve the problem of the sliding surfaces along which the drawer is supported (or suspended), the correct location of the drawer fronts, locks, handles, etc. The front part, for instance, should be attached by a threefold method to the plastic: first, the front part should be slid into its correct position; second, a strong adhesive should be used all along the surface of the contact (such as a suitably plasticized thermosetting resin), and third, the handles and knobs should be bolted right through both the front part and the plastic. These suggestions are, of course, arbitrary and have by no means been sufficiently studied. It would lead us too far to investigate the design problems in more detail. It can be seen, however, that there are a number of important considerations to be studied before designing plastic molds.

The molded shapes themselves can be produced either by compression or by injection molding by using current types of plastics or by using certain types of laminating and shaping processes. For *compression* molding, the suitable material should be a specially shock-resistant grade of urea-formaldehyde or phenol-formaldehyde resin combined with certain fibrous reinforcements to raise the impact strength of the straight plastic. The introduction of reinforcements, of course, imposes certain limitations on the original design, and it will be a matter of experimenting to get a right balance.

Injection molding gives apparently a greater freedom in the design and this process is technically very promising, as we could choose a suitably plasticized thermoplastic resin. Whether the cost would be permissible is, so far, a question which cannot be answered, but it is very tempting to choose one of the colorful thermoplastics, such as polystyrene. Other processes which can be used with relatively lighter tool costs are applicable where the number of pieces produced would not justify compression or injection molding. Within certain limits we could remold thermoplastic sheet material by the usual shaping processes to produce such drawer parts, though this type of manufacture is likely to remain the costliest as certain parts would have to be joined by an adhesive. Naturally there are newer processes in the melting pot, and we can anticipate that shaped parts will be welded some day. The plastic welding torch which can already be successfully used on a number of thermoplastics offers certain advantages for this type of operation although the use of the torch (operated with electrically or gas-heated air) still involves skilled hand labor.

The shaping of sheet material to form drawer parts is by no means confined to thermoplastics, as it may become possible to make use of laminated sheets (such as the rubber-oxide modified phenol-formaldehyde sheets) to form the two sides and the bottom of the drawer part, or by shaping the whole drawer out of such a moldable material with welded or otherwise joined edges.

This survey of plastics possibilities is by no means a complete one but it may indicate the amount of detail considerations which are involved in the mass production of apparently simple shapes, such as our suggested drawer parts, if we intend to use plastics to achieve some definite improvements.

Mobile furniture units

While smaller furniture components such as fittings, drawer parts and small built-in cabinets can be regarded as articles to be manufactured easily by plastics processors, it is likely that larger units of mobile furniture will have to be produced by woodworking companies or furniture manufacturers. Wardrobes and heavy, cumbersome furniture units will probably become more and more architectural components in the form of (*Please turn to page 158*)

Transfer molding of phenolic material*

by C. A. NORRIS†

A GREAT deal has transpired since the first thermosetting molding material was discovered by Dr. Baekeland in 1907. Not only have we witnessed the introduction of many new molding materials, but the whole art of fabrication has passed through an evolution until today the molding of plastics compares very favorably with the more highly organized methods of modern mass production used in other industrial fields.

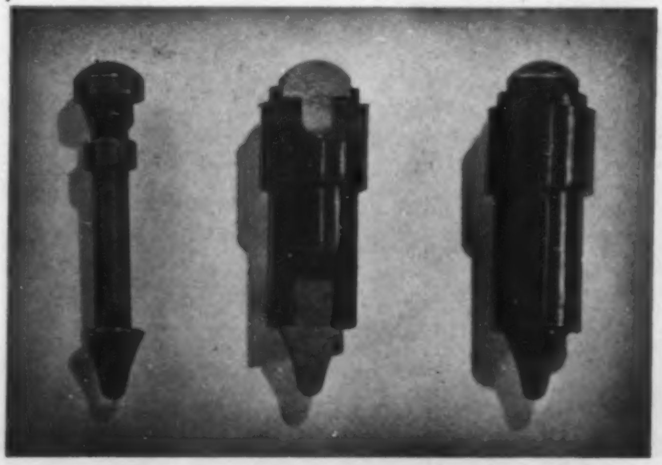
One of the outstanding developments that has played such a prominent part in the advancement of the molding art is the transfer method of molding of thermosetting materials. Therefore it is the purpose of this discussion to review the highlights of this development from the time of its inception until the present day. The transfer method of molding is also frequently referred to as injection molding of thermosetting materials. Because the term "transfer molding" was chosen by the originator of the process, Frank Shaw, its use will be continued here.

In recent years, the evolution in the art of plastic molding has taken place with such rapidity that it has been difficult even for those within the industry to keep pace with current developments. In order to appreciate more fully the progress that has been made, let us briefly turn back the pages and review the methods used in the past as compared with those of present-day practice.

* A paper presented before the Plastics Sales Engineers Association at the Yale Club, New York City, March 15, 1943.
† Service Engineer, Bakelite Corporation.

1

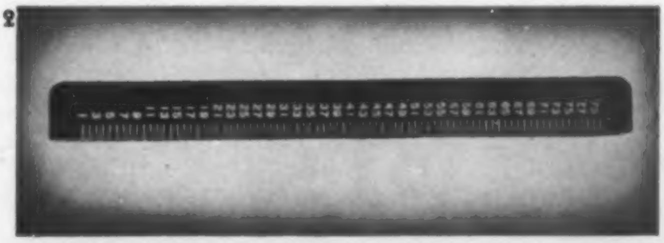
PHOTOS, COURTESY BAKELITE CORP.



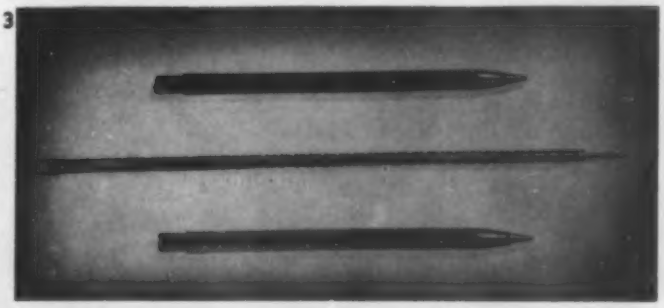
The first molded pieces to be made of phenolic thermosetting materials were produced in molds that had originally been built for the production of rubber parts. This came about in a very natural way because, after all, the initial interest shown in this new and unique plastic material came from the users of hard rubber parts as electrical insulation. As a result, the molding practice used for hard rubber was also applied to the fabrication of this new thermosetting phenolic molding material. Hand molds of the compression type were employed. The required amount of molding material was weighed in a cup or other container and placed directly into the cavity of the mold.

The molds were assembled on the molder's bench and then placed by hand in a comparatively small hydraulic press for the applications of heat and pressure. In many cases the hydraulic pressure was built up by means of a hand pump. This meant that the molding process was very slow. Multiple cavity molds were used in order to increase production, but they were still hand molds. As time went on, the need

2



3



1—First transfer molding job was this firing pin developed for the Navy in 1926. A vertical steel insert (left) was encased in phenolic. 2—Phenolic bar for business machines has graduations and figures molded-in. 3—Mechanical pencil cut away to reveal molded helical thread

for higher production rates and lower costs became more acute. To meet this need, the so-called semi-automatic press was developed about 1915, and was the first genuine advancement to be made in the technique of plastic molding.

The semi-automatic press

In the semi-automatic set-up, the upper and lower portions of the mold are rigidly fastened to the top and bottom parts of the press, thus eliminating the necessity for the operator's handling the mold manually. The semi-automatic press made possible the use of large multiple cavity molds, and mold size and press capacity were considerably increased. For some time the plastics industry went along without any other important change taking place in molding technique. Then something happened.

In the early part of 1926 the Shaw Insulator Co. was attempting to mold firing pins for the U. S. Navy. This piece consisted of a steel insert about $1^1/_4$ in. long that was to be encased in a shell of phenolic molding material. Then, as now, the dimensions were rather "fussy." This piece is shown in Fig. 1.

Attempts were made to produce this part by compression molding. The insert was not placed in a horizontal position in the mold because the high and unbalanced pressure exerted upon it might cause distortion. Also, the use of a split mold would undoubtedly cause the parts to be out of round, the extent of the eccentricity being measured by the thickness of the flash. In order to overcome these difficulties, the insert was placed in a vertical position. While the elimination of a split mold took care of eccentricity, it did not overcome the distortion of the insert.

The first transfer mold

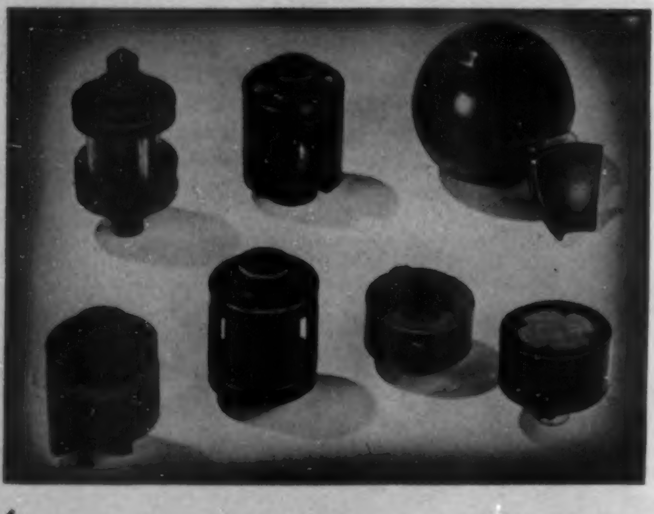
It was then that Mr. Shaw conceived the idea of placing the insert in the mold, closing the mold empty, and then—to use his own expression—"transferring" the molding material in a plastic state into the cavities through openings or gates from an auxiliary pressure pot, located above the mold proper. Thus transfer molding was born. This took place in the early part of 1926. The date is not only interesting but also significant, particularly when it is remembered that thermoplastic materials and injection molding machines were not in general use prior to 1930.

The results obtained on the firing pin job through the use of transfer molding were so encouraging that it was decided to try this method of fabrication on another part, this time for a different reason. The long narrow piece illustrated in Fig. 2 was being produced for one of the business machine companies. It carried both on its face and on its back a series of graduations together with numerical figures. These were formed as depressions in the molded piece, and were filled in with white paint to make them readily legible. The corresponding raised sections of the mold were continually being damaged and "washed off" by the action of the molding material when the parts were produced by compression molding. Mold repair costs ran high and in order to overcome this condition it was decided to convert this mold from a compression to a transfer type.

ALL PHOTOS, COURTESY BAKELITE CORP.

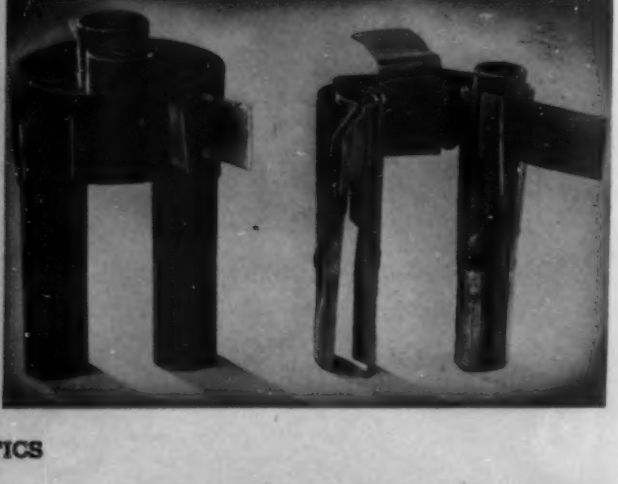
4

5

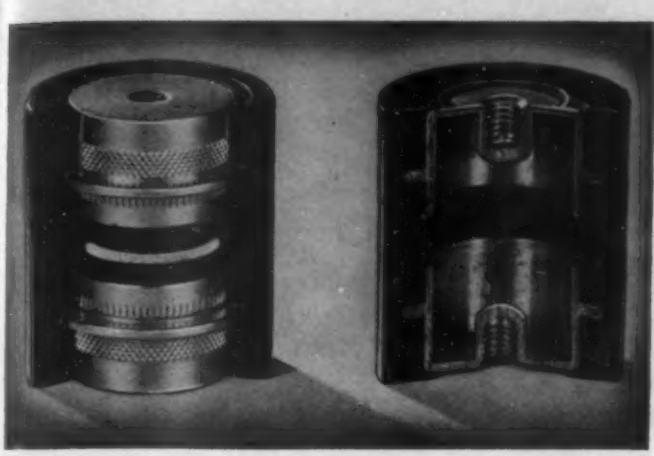


6

7



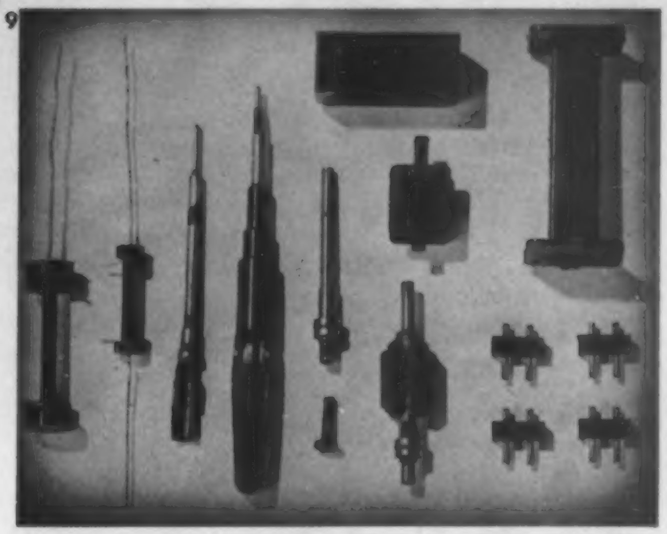
4—Transfer molded parts can incorporate a variety of inserts. Right center: a lining of .003-in. copper foil. Lower right: an insert projecting into cavity but not through sides of piece. 5—A second group of experimental moldings. Piece at upper left has sleeve, molded free of vertical steel inserts, which can slide up and down. At top center is a steel ball molded inside a completely enclosed cavity. Upper right: hollow undercut ball section cut away to show interior



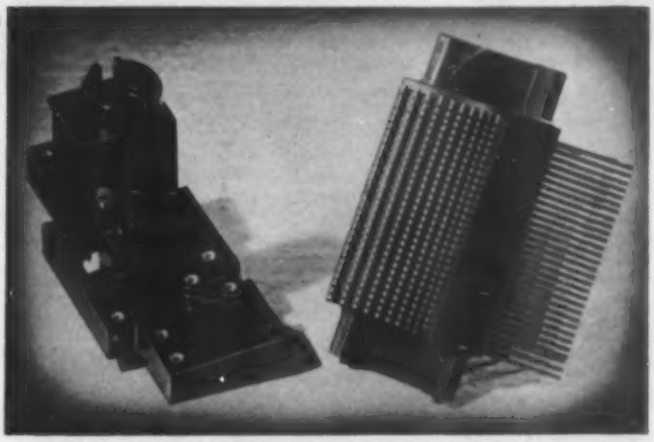
8

6—An electric eye has a glass window molded in place. 7—The delicate insert in this electrical part is made of .010-in. copper. Completed insert shown at right, completed piece at left. 8—Two sections of resistor unit with phenolic material cut away to show (left) inserts for resistor coil and (right) center section with resistor coil removed. 9—Some intricate small parts with precise inserts. Armature at lower center has phenolic material molded between connector rings. 10—Two fairly large and extremely complicated parts produced by transfer molding. Projections on piece at right are inserts, over 300 of which are molded into this piece. 11—Syphon bottle head shows intricate coring and mold pins

9



10



11

The results were very gratifying. The successful outcome of these two jobs led to a third—fountain pen barrels, heretofore a stubborn problem which challenged the ingenuity of the young but ambitious plastics industry. Most of the molders in these early days had at one time or another attempted to mold fountain pen barrels with varying degrees of success. All the compression-molding tricks known at the time were tried, but still the comparatively long and slender core pins would bend, with the resulting non-uniformity of wall thickness. By the transfer method of molding, high and unbalanced initial pressures were minimized because the material was brought to a soft plastic state before entering the mold cavity. Thus, core pin distortion was no longer a major problem.

Experience gained here was readily adapted to the molding of pencils (Fig. 3) which were turned out by the millions. These pencils are of the propel and repel type in which the lead may be advanced or retracted at will by means of a helical thread running the entire length of the barrel. They were produced in a multiple cavity mold using two rectangular pressure pots. This arrangement was chosen in order to obtain equal distribution of material over the entire length of the mold and at the same time to provide ample pressure chamber area.

Designing the pressure chamber

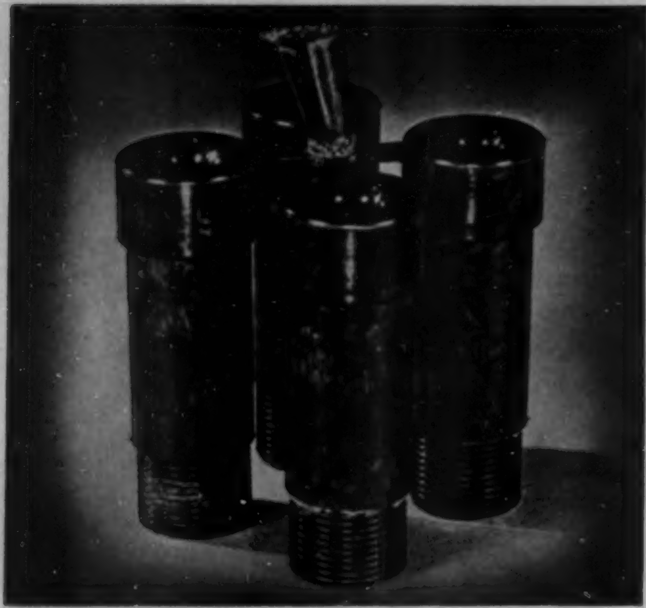
In the design of transfer molds, it is of fundamental importance to keep the area of the pressure chamber at least 15 to 20 percent greater than the projected area of the cavities. Thus the pressure exerted on the mold, tending to keep it closed, is at all times greater than that developed within the cavities trying to push the mold open. In the case of these pencils, there was no flash to speak of along the parting lines of the mold. The only finishing operation required was performed by the molder: he simply took a handful of the molded pencil barrels, rubbed them together in the palms of his hands, and the job was finished.

Experimental pieces

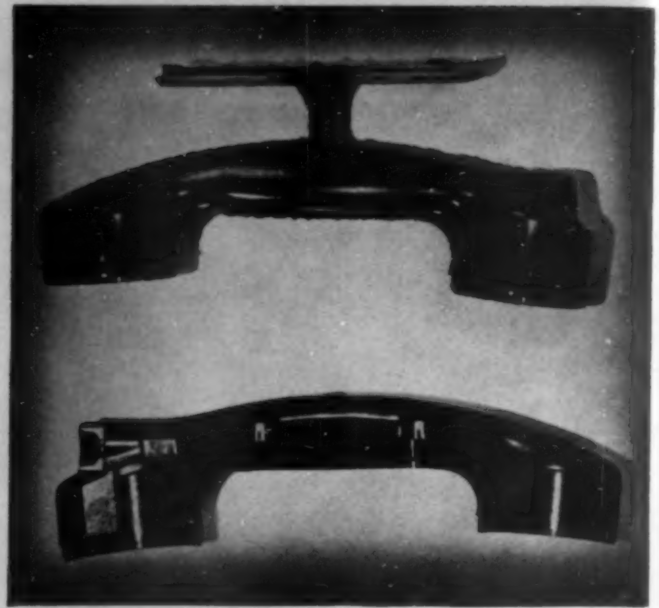
In order to investigate further the possibilities of transfer molding, a number of experimental molds were built. Some of the pieces produced in these molds are shown in Figs. 4 and 5. The cylindrical shaped objects are approximately $1^3/_4$ in. in diameter with an over-all length of about $1^3/_4$ inches. These, it will be noted, are hollow with closed ends except for a hole about $^3/_8$ in. in diameter. Sections have been removed in order to show internal details such as:

1) A glass rib projecting into the hollow inside portion, but not coming through the outside wall.

2) A lining of thin copper foil about .003 in. thick molded on the inside wall of the hollow cylinder. This has now be-



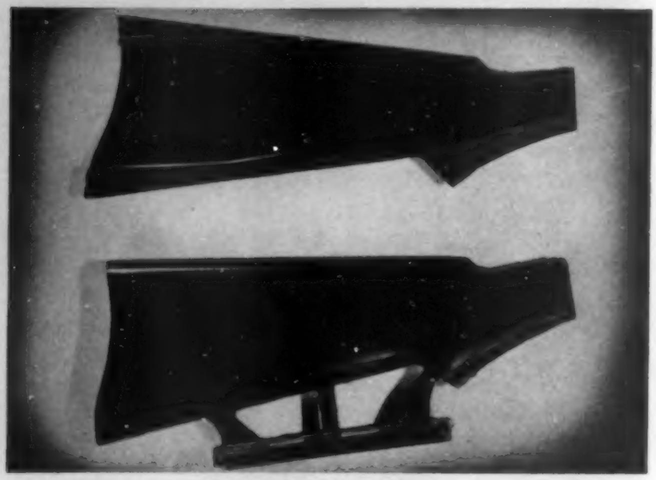
12



14

ALL PHOTOS, COURTESY BAKELITE CORP.

13



15

12—Complete shot of four threaded tubes of high impact material, shown just as they come from the mold. 13—A gear molded of fabric-base shock-resistant material. The four sprues connected the pressure chamber to the mold cavity. 14—Two views of molded telephone handset. At top, set as it comes from the mold, with sprue and pressure pot disk still connected. Lower view shows center section. 15—Gun stock molded of fabric-base material shown in cut-away section and completed piece. This piece was molded in an angle press equipped with two hydraulic rams

come rather badly torn due to sceptical investigators picking at it. They found it hard to believe their own eyes.

3) Threaded inserts incorporated so as to project into the hollow cavity, but not to extend through the sides of the piece.

Figure 5 illustrates more of these experimental parts. The piece in the upper left-hand corner has a one-piece floating ring, molded in place yet free to slide up and down on four vertical steel pins. These, too, were molded into place as inserts.

The next specimen shows a steel ball free to roll around inside the hollow cylinder which is molded around the ball in one piece. The hollow ball shown in the upper right-hand corner has an interesting feature which unfortunately does not show in the photograph: on the inside in raised figures is the date—November 27, 1929. Further evidence of the possibilities of this method of molding is brought out in the other pieces shown in the illustration.

While it is true that these parts might be called—or classed, rather—as "trick pieces" and not as commercial applications, nevertheless the information and experience gained through producing them have proved to be invaluable in solving some of the more difficult problems presented by industry.

For instance, in the electric eye shown in Fig. 6, a very important feature is the glass window in the front of the piece. From the experimental work carried on with the glass ribs in the hollow cylinders, it was learned that glass could be successfully incorporated into a molded object when the object was produced by the transfer method of molding.

Complicated inserts

Again, when a manufacturer of electrical instruments wished to insulate a complicated and delicate copper insert, the knowledge obtained from experimenting with copper foil proved to be very valuable. The insert and molded piece are shown in Fig. 7. The copper from which this insert is

constructed is .010 in. in thickness. Before going to transfer molding, attempts were made to cast insulating material around this insert assembly without success. After its adoption, the job was put into production, using a general purpose phenolic molding material.

The hollow resistor housing shown in Fig. 8 is another practical application of the experience gained by means of these early experiments. Here a delicate coil form wound with hair-like wire is completely encased in a molded housing.

The variety of small parts shown in Fig. 9 indicates the possibility of producing such delicate things as coil forms with molded-in conductors, intricate dental instruments known as pulp testers, molded insulation between tiny collector rings and small armature shaft, minute bushings with a hole only a few thousandths of an inch in diameter running its entire length, spools with thin walls, insulation supporting delicate contacts. Two other pieces, larger, but no less complicated, are shown in Fig. 10.

The syphon bottle head shown in Fig. 11 is a good illustration of what may be accomplished in a part which combines a difficult coring problem with the use of metal inserts.

All of the applications so far described were produced from woodflour-filled phenolic molding material, unquestionably the most readily moldable type in the thermosetting group of plastic materials. For some applications, the woodflour-filled molding materials were not strong enough to meet the service requirements. The question then came up, "Can the extra-strength, shock resistant materials be fabricated by this molding process?" There was some real scepticism in the minds of some people, but we have the answer in the following illustrations.

Shock-resistant materials

The threaded tubes shown in Fig. 12 were molded of fabric-base, shock-resistant material. A four-cavity mold equipped with a single round pressure chamber has been turning out these parts in production quantities for several years. A sprue of approximately 1/2 in. in diameter and molding pressures in the neighborhood of 26,000 p.s.i. were found to be desirable. The molded gear, Fig. 13, is further evidence of the successful results obtained through the use of shock-resistant materials. In this case, four sprues, each about 1/4 in. in diameter, were used to connect the pressure chamber to the mold cavity.

Telephone handsets, Fig. 14, which must withstand rough field service with our armed forces, are also produced from shock-resistant materials. The piece shown in the illustration was molded in an angle press equipped with two hydraulic rams, one to hold the mold closed, the other to exert the necessary force on the pressure chamber. In this arrangement, it is not necessary to maintain the differential ratio between pressure chamber and cavity area mentioned above, inasmuch as the mold is held in the closed position by means of the auxiliary hydraulic ram.

Another assembly showing the use of fabric-base material together with the angle press set-up is illustrated in Fig. 15. This, as may be seen, is a transfer molded gun stock which was formerly made from wood.

Mineral-filled materials

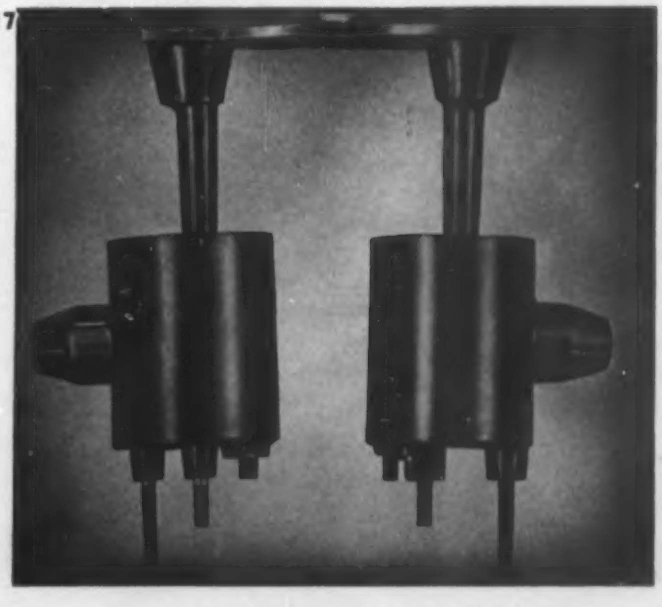
Some of the most difficult thermosetting materials to mold are those found in the mineral-filled group. The two parts pictured in Fig. 16 are molded from long-fiber asbestos material. The piece on the left is 12 in. in over-all length. Its design and insert assembly make it a difficult molding job at best, but when produced from long-fiber asbestos material it is a real accomplishment. The commutator shown on the right is made up of copper segments which are encased in long-fiber asbestos molding material.

Mica-filled molding materials used for low loss electrical insulation have always been difficult to mold. The radio coil forms shown in Fig. 17 are made from this type of material. Here a two-cavity mold with a single round pressure chamber was used.

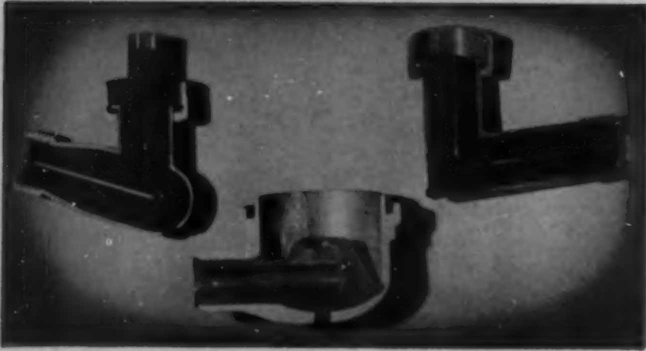
In the shielded sparkplug elbows pictured in Fig. 18, the electrical insulation required for the high tension current is provided for by the use of phenolic material transfer molded into place. A mineral-filled type is used to insure sufficient heat resistance to withstand the elevated temperatures encountered. The airplane ignition parts shown in Fig. 19 are not only massive in section, but also include a complexity of insert assemblies. These parts are being successfully put in production by the transfer method of molding. Melamine molding material is used in order to take advantage of its superior arc-resistant qualities. In Fig. 20 are illustrated the component parts of probably the most discussed job in the plastics industry today. It is the M-52 trench mortar shell fuse. The nose and cup are produced by compression molding and, for this reason, will not be further considered here.

(Please turn to next page)

16


17


16—Two parts transfer molded of long-fiber asbestos material. The long, slender insert in piece at left makes it a difficult molding job. The copper insert segments of the commutator at right are uniformly molded-in. 17—Booster coil housing molded of mica-filled phenolic material. Two-cavity transfer mold was used for these pieces



18

19

ALL PHOTOS COURTESY BAKELITE CORP.

18—Three different types of shielded spark plug connector elbows. The metallic shielding completely encloses the mineral-filled phenolic material. 19—The arc-resistant qualities of melamine molding material are utilized in aircraft engine ignition parts of heavy section comprising numerous inserts. 20—Complicated body of M-52 trench mortar shell fuse is of medium impact phenolic material, with all dimensions held to close tolerances

The body, which is the most complicated of the three pieces, is being produced by the transfer method of molding, using a medium impact phenolic molding material. Most of the dimensions must be held to very close limits. This, of course, makes necessary the very careful checking of these parts for dimensional accuracy. By so doing, some very interesting observations have been made. One in particular is the "apparent growth" or elongation of the parts after the molding pressure has been released. Under certain conditions, the over-all length of these bodies has actually been observed as being .025 to .030 in. longer than the mold in which they were formed. This condition is apparently produced by a combination of compressibility and flexibility of the molding material.

It is an established fact that both of these properties are existent in phenolic molding material of this type. Compressibility may be observed by applying a given pressure to a mold charge of material loaded into a full positive mold. After sufficient time has elapsed for the material to become completely soft and plastic, but not yet set up, if the applied pressure is doubled, the plunger will move down, signifying that the material is being compressed. The flexibility of molded pieces at the time of discharge from the mold is the basic principle by which millions of bottle caps have been produced by the so-called "stripping process."

Since these two conditions are known to exist, it seems logical to assume that the elongation of the parts in question is brought about by the material's being compressed in the mold cavity under high pressure. When this external pressure is released, the parts then expand or elongate, relieving the internal pressure built up within the piece. This is made possible due to the flexibility of the molded part at the time of discharge.

This theory may also help to explain why cracks are sometimes encountered in the molded body of the M-52 fuse. While internal stresses are undoubtedly directly responsible for the cracking that takes place, it seems highly probable that there is a close relationship between this action and elongation. Investigational work now being carried on may not only prove this theory to be correct, but also point the way to the control of dimensions within limits through molding pressure.

A more recent development in the molding of thermosetting materials is the so-called jet molding process. Patents have been issued to C. D. Shaw covering this molding process and Plastics Processes, Inc., is the licensing agent.

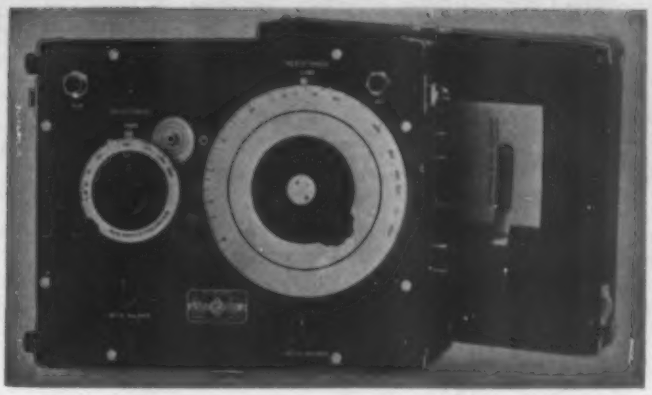
In this process, the mold is also closed empty and the material in a plastic state is then forced into the cavity through suitable openings. The basic difference between jet molding and transfer molding is in the method used in applying the necessary heat to polymerize the material. In jet molding a comparatively low temperature is maintained in the pressure cylinder. The heat input is sufficient to preheat the material, but not great enough to cause it to react quickly or set up. Between the pressure cylinder and the mold there is a nozzle or jet, so constructed that extreme heat may momentarily be applied to the molding material during the time it is being injected into the mold. Upon the completion of this operation, the nozzle or jet is rapidly cooled by means of circulating water. The material left in the nozzle solidifies but does not polymerize. Thus it can be made to flow under heat and pressure even after being held in the nozzle for a long period of time. Due to this feature, the molding can be done on a continuous basis.

Standard injection molding machines can be converted to handle thermosetting materials by equipping them with the jet molding type of heating units. Thus another advancement has been made in the art of molding thermosetting materials. Through the development of these processes, the field of plastics has been greatly broadened and jobs that heretofore were impractical, if not impossible, are now accomplished facts.

A sign once seen in a blackmith's shop might well apply here. It read, "The difficult jobs are done right away; the impossible ones take a little longer."

20

Insulation for Wheatstone bridges



WHEN a new polystyrene-like material was announced a few months ago, General Radio Co. became very much interested for several reasons. Foremost among these was the fact that this material had a 15° higher softening point than polystyrene. Additional advantages included availability of larger sheet sizes, lower prices and far better deliveries. Furthermore, the opaque nature of this new product made much less obvious the craze lines which always accompany high stress in polystyrene although they usually are not harmful to anything but the appearance of the product.

In the manufacture of one of the company's radio frequency bridges, polystyrene had been used previously for combined structural and insulating parts and was found acceptable. Other solid dielectrics had proved unsatisfactory, primarily because of their high dielectric constant and brittleness. Since most ceramics have a dielectric constant of between 6 and 7, they could not be used in this radio frequency bridge because it just plain cannot be made operable if the stray capacitances should be $2^1/_2$ times what they now are. Thus, due to the fact that the dielectric constant of polysytrene remains unchanged from 60 cycles to 60 megacycles at 2.5 to 2.6, the company, through triple shielding and insulating with styrene compounds, was practically able to eliminate stray capacitances. As it was, the bridge required considerable design work to make it small enough to be portable without, at the same time, again increasing these capacitances beyond what could be tolerated.

In general, properties required in insulating material for these parts of the bridge are as follows: low and permanent dielectric constant and power factor; dimensional stability; freedom from creep; mechanical properties sufficient to provide adequate support for dependent parts during manufacture and use, and to withstand the shocks and vibration incident to transportation.

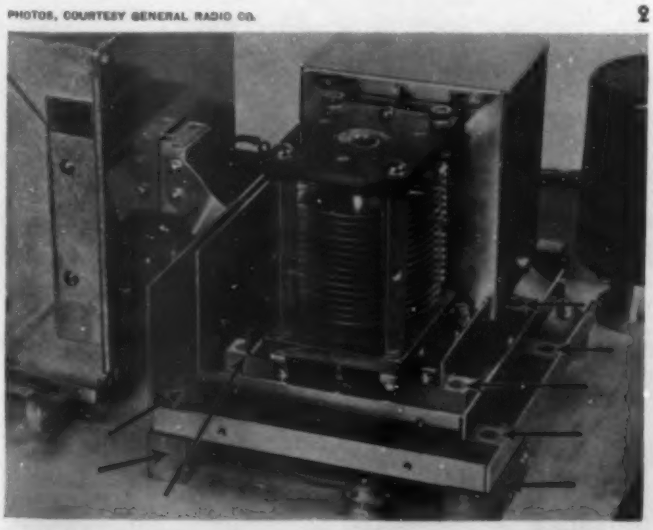
Polystyrene, to be sure, was doing the job, but science does not stop at just "getting by," and this new styrene-like material had several advantages which made it desirable for this type of application. It was more easily machined, was far less brittle and, with its higher softening point, made a far more satisfactory product. It is true that it has a less attractive color and a somewhat lower (though still adequate) tensile strength, but its advantages outweigh its disadvantages.

All of the parts designed for the new material now used in this bridge are machined by sawing on an ordinary saw table, drilling, counterboring and tapping. Some contain knurled brass inserts which are assembled by being heated and forced slightly into counterbored holes. All combine structural and insulating functions, and are used as mounting blocks to support current-carrying parts of the Wheatstone Bridge operated at different voltage levels at frequencies as high as 60 megacycles. Some separate a succession of nested shields from the panel and from one another. Another supports switch clips in a range switch. Still another is the insulating body of an ultra-high-frequency standard (*Please turn to page 134*)

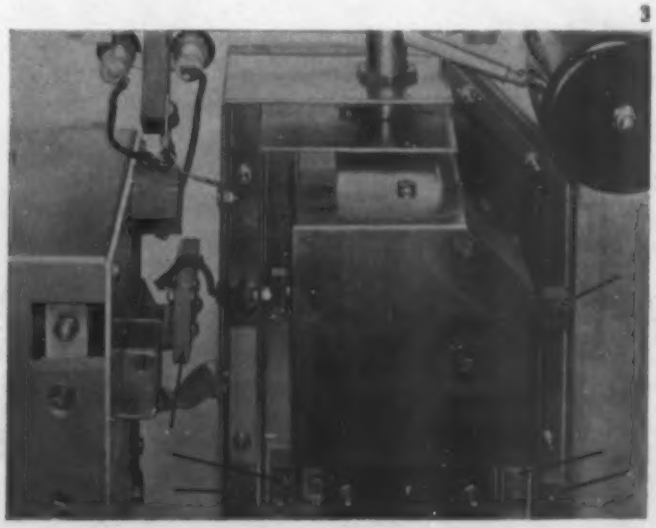
1—Panel view of Wheatstone bridge with cover removed. Through the hole in the panel between the two dials can be seen the plastic slab which covers it from the rear and on which a pin jack is mounted. 2—Interior of condenser compartment shows the blocks of plastic material which support the inner, middle and outer shields, and insulate the latter from the panel. 3—Rear view of condenser shows small parts machined from polystyrene-like plastics, and (at left) the insulating body of the ultra-high-frequency resistor, which is of the same material

PHOTOS, COURTESY GENERAL RADIO CO.

2



3



Handling thermoplastic materials

MANY difficulties experienced by the molder of thermoplastic materials may be traced directly to improper handling of such materials prior to their actual use. The presence of moisture in the material, or its contamination by other thermoplastics or by dirt, is not unusual. It is true that in a few isolated cases raw material manufacturers have shipped material to molders which was substandard, and in a very few cases some dirt has been found in drums of virgin material; but such cases have, in fact, been few and far between. Raw material manufacturers, however, know (to their sorrow) the number of complaints which have been laid directly on their doorsteps. In many of these cases, unsatisfactory material could not be blamed on the material manufacturer, but rather on the molder for his lack of care in the handling of the material.

It has been brought to our attention that in some cases molders have actually used trays of different types of thermoplastic material in the same drying oven. This is not good practice, due to the presence in these materials of various plasticizers, some of which may be incompatible and act as contaminating agents. In several cases, conditions of streaking have been discovered in the finished product. The molder promptly called in his supplier's material technician and eventually traced this difficulty to the above mentioned improper drying practice. In some cases the difficulty was traced to the fact that drying ovens were located too close to molding equipment which was handling other types of material.

The Engineering Section of MODERN PLASTICS, with the cooperation of several of the large material producers, has attempted to make a study of the situation and at the same time to offer some constructive ideas in an effort to help eliminate these difficulties.

It is true that many of the suggestions which have been advanced could be called elementary, but it is also true that in a great many cases even these elementary precautions are not followed. Raw material, which costs anywhere from 30 to 90 cents a pound, is a rather expensive commodity, and great care should be taken in its storage, handling, drying and loading. Although some thermoplastic molding jobs call for a small amount of material, in many cases a drum or less, the majority of production runs call for thousands of pounds of material, all of the same color, same granulation and same flow.

Storage conditions

When the molder receives a job of the latter type, he generally places a covering order with his material supplier for an amount of material which will be sufficient to complete the entire run or firm release, and when he receives this material, he is, therefore, immediately faced with a storage problem. The material is shipped in fiber drums, and the molder will generally stack these drums in some portion of his plant which has been set aside for raw material storage. If this molder handles thermosetting as well as thermoplastic materials, he should set up in his plant two points of storage, one for thermosetting materials and the other for thermoplastics. At no time should these two different types of materials be stored in the same storage room. Thermosetting materials, as a general rule, are in powder rather than in granular form. Therefore, when the tops of the drums are removed, a certain amount of this powder will circulate in the air and, beyond a doubt, will be a contamination hazard.

With regard to the storage facilities for thermoplastic material, there are several points which should be taken into consideration:

Does the room have a concrete floor? Is it located in the basement or on one of the upper floors?

Is heat available? Is there a possibility of arranging for a system whereby warm, dry air may be forced into this storage place?

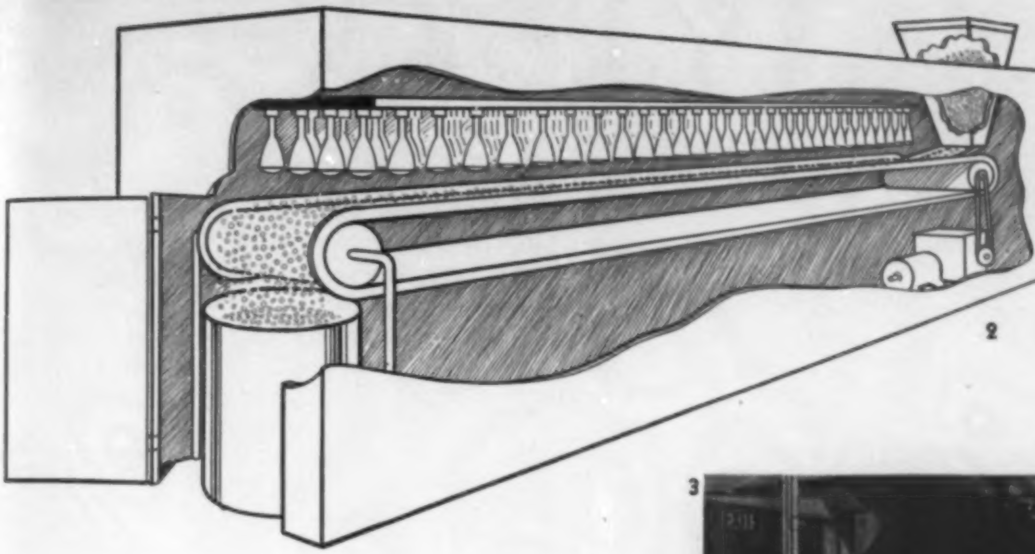
Is there a chance that windows may inadvertently be left open, thus exposing some of the drums of material to the elements?

How is the ceiling of this storage room constructed? Is it completely dust-proof, or will overhead traffic drive dust and dirt through the cracks?

If the storage room has a concrete floor, it is always wise to build a wooden platform a few inches from the floor in order to minimize the transfer of moisture from the floor to

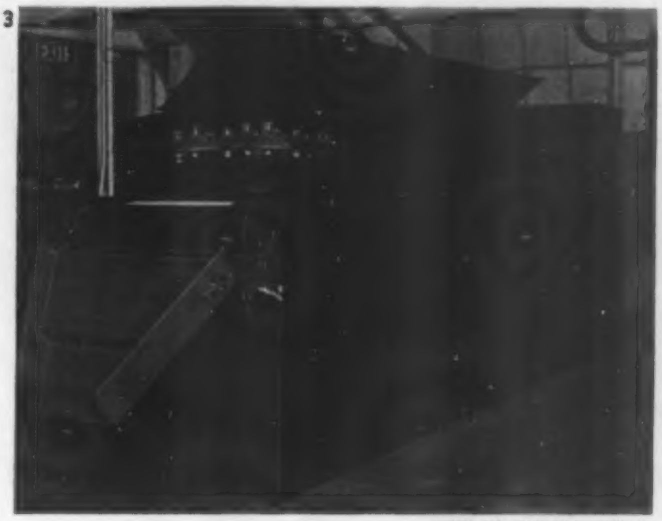
PHOTO, COURTESY WESTINGHOUSE ELECTRIC & MFG. CO. 1

1—In drying ovens heated by infrared lamps, trays of material must be placed far enough apart to allow for a bank of lamps above each tray. Drying time is from 10 to 20 min., and material must be agitated at intervals



2—Completely enclosed belt drier makes use of infrared lamps and controlled feeding mechanism. Dried material can either go directly to molding machine or be stored in moisture-proof containers. 3—Belt type drier which is not completely enclosed is not dustproof

3



PHOTO, COURTESY FORD MOTOR CO.

the bottoms of the drums. This is especially true if the location of the storage room is in a basement—which location, by the way, should be avoided if at all possible.

In all storage rooms, heat or a warm air supply should be available, for it is only by this means that the moisture can be kept at a minimum. Hot, dry air under forced feed is by far the best means of accomplishing this end. By the use of circulating hot air, the humidity of the room is kept at a minimum.

Any windows or skylights in the storage room should be firmly nailed shut, for it is only natural that a man working in an elevated temperature such as will be encountered in this type of storage room will open a window to get a breath of fresh air. A sudden storm can cause incalculable damage.

The overhead ceiling should in all cases be completely dustproof. Too much emphasis cannot be given to this very important point for, if the plant is rather old, the overhead wooden floors will without a doubt be seamed with cracks. If this is so, the ceiling should be lined with some type of material which will completely seal off the upper portion of the room. A metal ceiling will do a very good job, but even a large tarpaulin hung from the rafters will be better than nothing at all.

It may seem that too much stress has been placed upon the storage room, but it is at this point that the difficulties originate; and if the material has been improperly handled in storage, any precautions taken in preheating will be to no avail. The storage room should be laid out so that there is ample aisle space for handling equipment, and definite sections should be allocated for the different types of materials. A complete "in and out" material inventory should be kept at all times. This inventory should not only include the type, color and flow of material, but should also indicate its approximate location in the storage room.

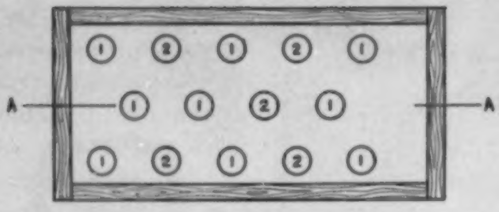
If all these precautions are observed, the material can easily be delivered to the molding room in first-class condition; and with such a set-up any reputable molder's complaint would bear far more weight with the material supplier than it would were the storage facility some dark, damp, dirty room.

Moisture elimination

Even when he has eliminated the possibility of contaminating his materials with dirt, the molder will still find that they have picked up enough moisture to become unmoldable, as a general rule, without preconditioning before they are loaded into the hoppers of his machines. Containers of plastic material formerly employed high grade moisture-resistant liners some of which are no longer available, due to war conditions. The use of substitute liners has increased the possibility of the material's absorbing moisture while still packed in the original container. This preconditioning entails the reducing of moisture content down to about one-half of one percent. There are various means of accomplishing this, the most common being the use of a drying oven.

In addition to the many types of ovens manufactured as standard equipment, many molders have designed and constructed ovens to their own specifications. Ovens may be heated with steam, electricity or infrared lamps, but in all cases they will make use of layers of trays. In ovens heated by electricity or steam, the trays of material may be placed fairly close together, whereas those heated by infrared lamps must allow space for a bank of lamps above each tray (Fig. 1). In electrically or steam-heated ovens, a circulating air supply should be available to carry off the moisture, and the temperature should be set at approximately 150° to 180° F. It is recommended that the material be placed in the trays to a depth of from 1 to $1^1/_2$ in. and permitted to dry for approximately two hours. (This is not true for all materials but is a good general rule to follow, for in the great majority of cases this time is sufficient to bring the moisture content down to about one-half of one percent.) During this time the powder should be agitated at intervals in order to have uniform drying throughout the entire mass.

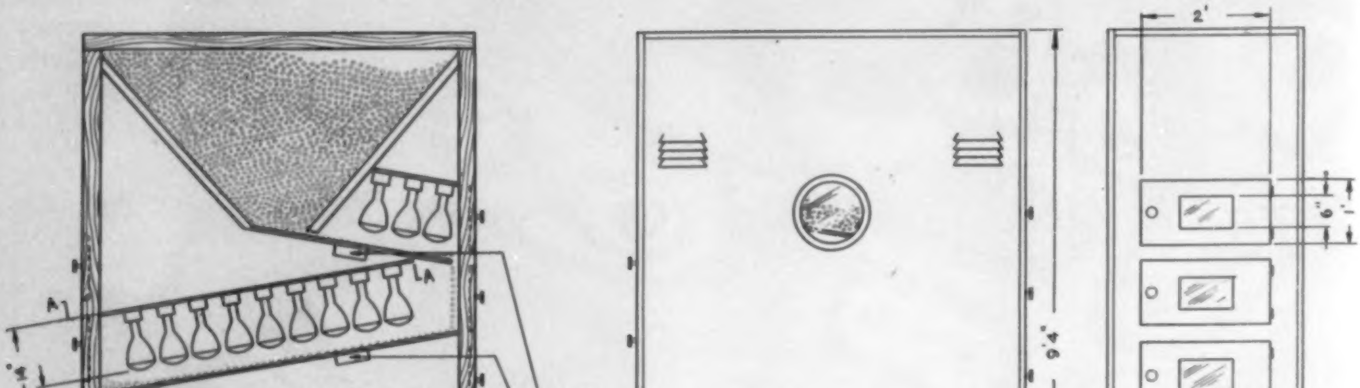
If infrared drying is used, material should be placed to the same 1 to $1^1/_2$ in. depth in each tray, but the time of



Section thru A-A showing suggested arrangement of one bank of infra-red lamps. Numbers shown indicate parallel wiring.

DIFFERENT HEAT INTENSITIES AVAILABLE WITH THIS HOOK-UP

SWITCH #1	SWITCH #2	NO. LAMPS ON
OFF	OFF	0
OFF	ON	5
ON	OFF	9
ON	ON	14



4—A completely automatic infrared pre-drying unit can be mounted above feed hopper of each molding machine. By means of vibrator and feed chute angle adjustments, volume of material fed into hopper of molding machine can be varied to meet requirements. Side view of unit (right) shows glass-paneled compartment doors to facilitate cleaning and inspection. Volume of material is checked by means of bull's-eye in side of hopper. Bank of switches (upper left) is wired for variable light intensity combinations. Sizes are merely suggested, may be varied to suit equipment capacity

drying will be far less than that taken by steam or electric drying. Allow from 10 to 20 min., depending on the color, but it will still be necessary to agitate the material three or four times during exposure to ensure even drying and no caking of the powder. Transparent and translucent materials dry faster than opaque materials under infrared light. The intensity of the light generally recommended is about one watt per sq. in. of material surface exposed, and when use is made of the built-in reflector type of infrared lamp, the distance from the lamp filament to the molding powder's surface should be between 8 and 11 inches. In general, the lamps should be placed in a dryer on from 6- to 8-in. centers. The number of lamps placed in the dryer in this particular arrangement can be mathematically calculated by knowing the amount of material to be dried per hour and the wattage needed per square inch of surface, which is given above as one watt.

In most cases, the thermoplastic material may be taken directly from the dryer and placed in the hopper of the molding equipment. In certain cases, such as extrusion molding, where the tolerances of the extruded part are directly proportional to the amount of material in the hopper, the pre-dried material may be placed into a metering device instead of directly into the hopper of the machine. In many cases, this metering device is equipped with a few infrared lamps.

Prevention of clogging

In tray-drying of ethyl cellulose of the softer, non-rigid type, some additional care must be exercised. When this plastic is dried in the customary manner—that is, in the usual circulating air oven or with infrared equipment at temperatures of from 150° to 180° F.—a condition suitable for hot plasticizing is readily obtained. If the material is then charged into the feed hopper or metering device in its warm condition, the weight of a hopper-full of material will cause a mass of granules in the throat which feeds the extrusion screw or metering cylinder to coalesce and stop the free flow of material into the heating chamber. This is a consequence of the relatively low softening temperature of this material which, although it does not fuse at the 150° to 180° F. drying temperatures, softens enough at the surface to produce, under slight pressures, sufficient coalescence between granules to cause a plug in the feedway.

To prevent such clogging the obvious thing to do is to put the dried granulations into a closed container and allow them to cool at room temperature, (*Please turn to page 154*)

Molded valves for oil well pumps

IN all the wars which have been fought up until this present global conflict, it has been common knowledge that an army "travels on its stomach." Der Führer, however, with his grandiose scheme of world conquest, has changed this old and tried method for the transportation of the armed forces. No longer does an army travel on its stomach but rather it travels on its oil. The majority of the major engagements have been fought and a great deal of the strategy of this war has been planned to gain possession of oil-producing territory, for without vast supplies of oil an army becomes as impotent as if it were attempting to fight without food. An army starved for food makes a poor fighting force, but a modern mechanized force without oil is easy prey for a far inferior force with ample supplies of this important fuel.

The eastern seaboard this winter has been given a very good example of what happens when oil supplies are lacking. Any motorist with an A book can easily visualize the dire straits an armed force would be in if it, too, were rationed in so necessary a commodity. It is true that the oil shortage in the East has come about chiefly because of lack of transportation, and that the oil fields in the Far West are producing ample supplies of oil. A great deal of oil, however, is found in the Pennsylvania fields, and if the pumping capacity of these fields could be enlarged, the shortage in the East would to a great extent be lessened.

One of the first thoughts in increasing oil pumping capacity is decreasing the "down-time" of the pumps now at work. This "down-time" is due to many types of equipment failure.

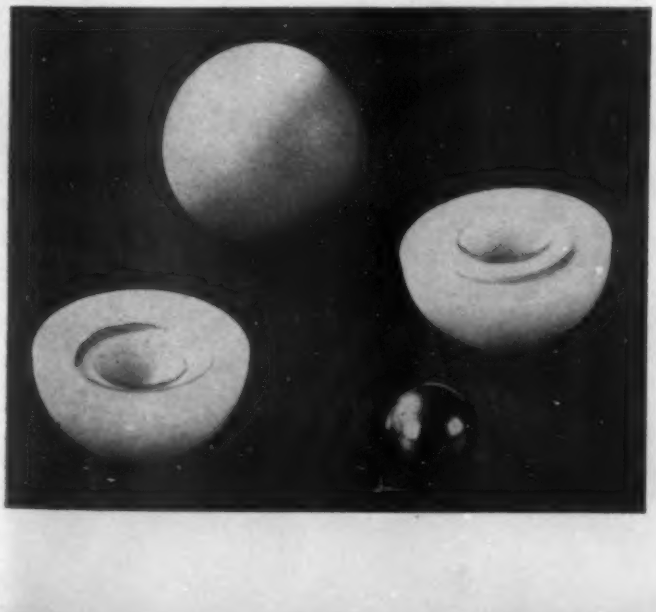
Figure 2 shows a typical pump assembly. In this assembly Part 3 and Part 11 are ball and seat valves, on the operation of which depends to a great extent the efficiency of the pump; for if the seal between this ball and seat is not perfect, oil which has been drawn into the working barrel seeps back into the well before the plunger has time to return again to its pumping stroke.

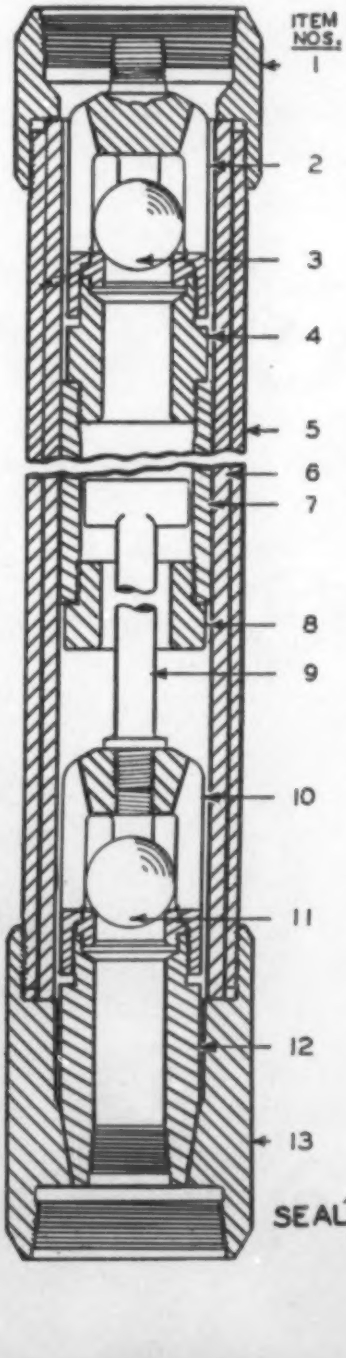
The majority of valve seats have in the past been manufactured from bronze, monel metal and some of the higher tool steels, all of which metals were in time damaged either by the electrolytic action which is inherent in oil wells or by corrosion due to contact with such elements as calcium, salts, sulfur, gypsum, etc. It is reported that these metal valves and seats had to be changed approximately every ten days which, depending upon the depth of the well, required up to 5 or 6 hours of "down-time" because the entire pump assembly must be pulled to replace a damaged valve and seat.

Faced with this maintenance (*Please turn to page 130*)

1—Completed plastic ball after it has been ground to perfect spherical shape. Below, halves of the ball are injection molded of cellulose acetate butyrate with a space left for insertion of the steel ball which increases the specific gravity of the assembled unit. 2—Typical oil well pump assembly. At lower right, the sketch of ball and seat shows the plastic shoulder, at which point the assembly vacuum seal is made in the pumping unit

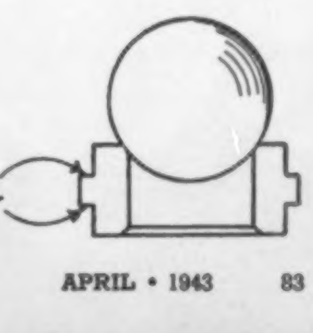
1





2

Item no.	Description
1	Collar
2	Open cage
3	Ball and seat
4	Plunger bushing
5	Jacket
6	Liner
7	Plunger
8	Plunger nut
9	Garbutt rod
10	Open cage
11	Ball and seat
12	Standing valve body
13	Shoe



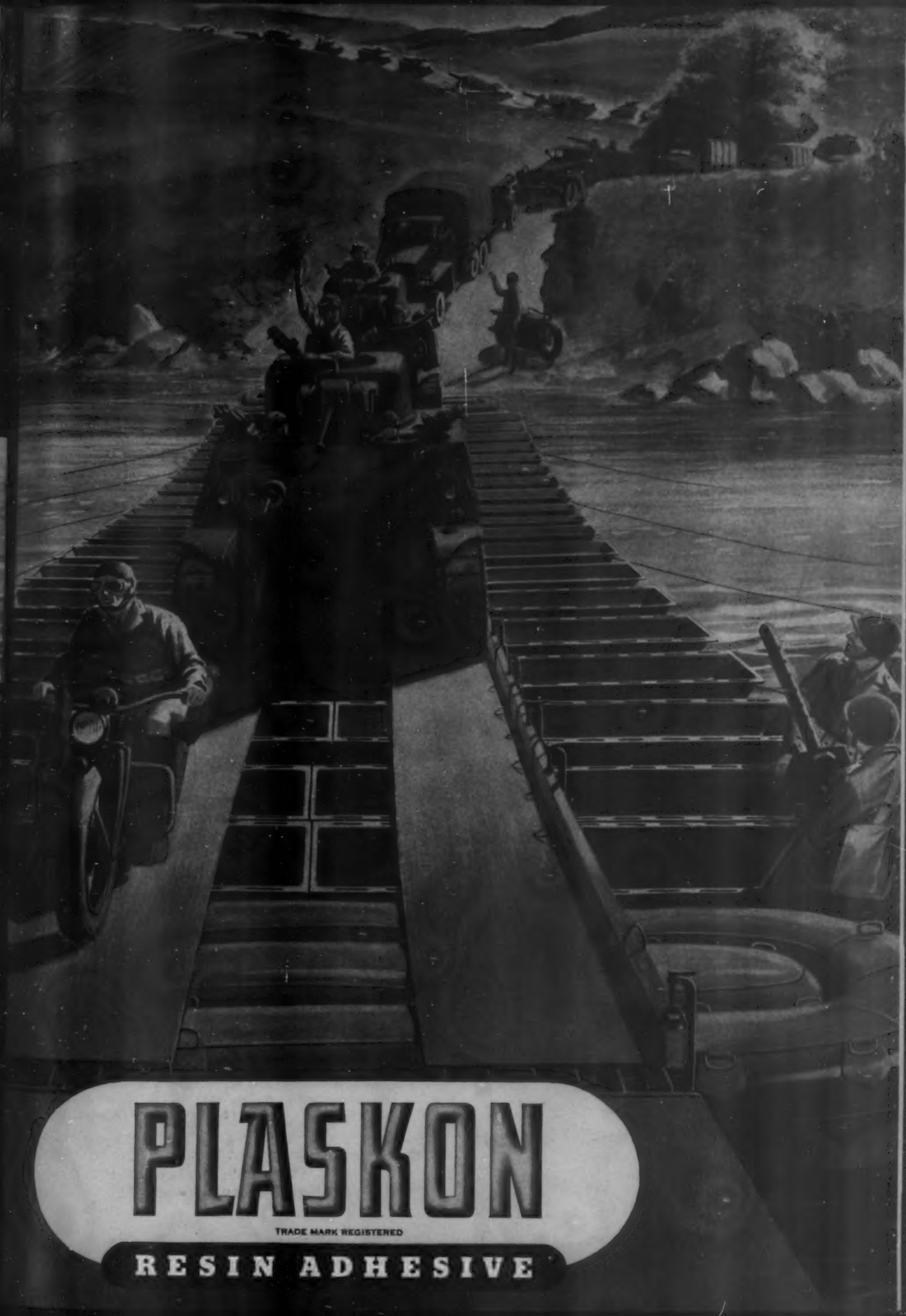
HERE THEY COME-

across a bridge of Plaskon-bonded plywood!

● Tons and tons of tanks, trucks and other heavy artillery, quickly and safely bridging a stream . . . because Plaskon Resin Adhesive makes possible the construction of light, tremendously strong plywood treadways and pontoon boats. Easily-handled, easily-placed, they are indispensable for the fast, strategic movement of our armed forces. Plywood or laminated wood bonded with Plaskon Resin Adhesive has an exceptionally long life, because of the almost indestructible nature of the glue. The wood remains tough, splitproof, resilient and fire-resistant indefinitely, because Plaskon Resin Adhesive is permanently waterproof and completely resistant to bacteria and fungi. This assures enduring service under water, on land and in the air.

Plaskon Hot Press and Cold Press Adhesives are being used in large quantities for cargo planes; training planes; merchant ships; supply barges; airplane propellers, fuselages, wings, noses, pilot seats; gliders; life rafts and buoys; army skiis; prefabricated houses; truck bodies; and many other wartime jobs.

Plaskon Waterproof Resin Adhesives fully meet requirements of Army-Navy specifications covering such Resin Adhesives. At present these glues are available only for high-priority applications. Plaskon Company, Inc., 2121 Sylvan Avenue, Toledo, Ohio.


PLASKON
TRADE MARK REGISTERED
RESIN ADHESIVE

Stock molds

SHEET ONE HUNDRED THIRTY

Shuffleboard equipment, photo frame, salt and pepper shakers, hot pad and mascara container are available from stock without mold cost, provided that restrictions on supplies of raw material, etc., have not limited current production. Write Stock Mold Dept., Modern Plastics, Chanin Bldg., N. Y.

1517. Glide disk, 6 in. in diameter, 3/4 in. thick, black and contrasting colors. Can be molded with 1 1/4 in. center hole for use as handwheel on lathe collet drawbars

1518. Cue head molded with standard wood handle screw threads. Front of cue fits 6 in. disk. Weight 6 oz., spread 3 1/4 in.

1519. Balcu cue head, steel with plastic ball runners; has socket threaded for standard wood handle threads

1520. Lightweight cue head with steel swivel for attachment to wood handle

1521. Cue head with swivel socket handle threaded for standard wood handle threads. Weight of head 8 oz., spread 5 in.; also available in 12 oz. weight

1522. Disk, same as 1517 but all black

1523. White mascara container, 3 in. long, 1 1/2 in. wide, 1/2 in. deep. Lift-off cover

1524–5. Combination salt and pepper shakers in red and white or green and white; 2 sizes: 3 in. high, 3 in. wide at base; 1 3/4 in. high, 1 5/8 in. at base. Refill by removing top section

1526. Hot pad, 5 in. in diameter, 1/8 in. thick

1527. Photo frame, 2 3/4 in. wide, 3 3/4 in. long, 3/16 in. thick. In crystal clear, amber or pink transparent

Thermoplastic Order M-154 Revised

In a sweeping revision of Thermoplastic Order M-154 issued by WPB, approximately 250 new articles were added to the list of products which may not be manufactured, regardless of preference rating. As may be seen in the complete Order below, an "existing stocks" exemption was placed in the order, allowing molders to use thermoplastics for the manufacture of the prohibited item provided such material was in their possession prior to the effective date of the restriction on such articles. In addition, if the material was in the possession of the molder's thermoplastics supplier and was processed prior to the effective date of the restriction on the manufacture of the prohibited article so as to render impracticable the use of the material for products not prohibited by the order, delivery and use may be made of the material.

It should be noted that the "war use" exemption is applicable only on those prohibited articles listed in Exhibit A of the Order which are marked with an asterisk (*). In other words, if the item is in Exhibit A and not marked by an asterisk (*), it cannot be manufactured, even for the Army, Navy, Coast Guard, Maritime Commission or War Shipping Administration. If it is marked by an asterisk (*) and the manufacture of the item is being done pursuant to a contract with one of these agencies, then it is not in violation of the Order and is allowable.

PART 1233—THERMOPLASTICS

[General Preference Order M-154, as Amended March 26, 1943]

Section 1233.1 is hereby amended in its entirety to read as follows:

§ 1233.1 *General Preference Order No. M-154*—(a) *Definitions.* For the purpose of this order "thermoplastics" means the synthetic resins and cellulose derivatives listed below, whether plasticized or unplasticized (except in the case of ethyl cellulose and cellulose nitrate), in their various primary unfabricated forms such as sheets, rods, tubes, shapes, slabs, pellets, powder, solutions, emulsions, and flake, and whether virgin or scrap, but not including yarn or textiles, coated or substrated photographic film or film scrap, or cellulose film up to .003" in gauge:

(1) Cellulose acetate butyrate.

(2) Cellulose acetate.

(3) Plasticized cellulose nitrate, except that used in explosives and protective coatings.

(4) Plasticized ethyl cellulose.

(5) Polymers and copolymers of styrene, except styrene copolymerized with butadiene.

(b) *Restriction on use.* (1) No person shall use thermoplastics in the manufacture of articles set forth in Exhibit A annexed, regardless of preference ratings.

(2) No person shall use in the manufacture of any article not set forth in Exhibit A annexed more thermoplastics than are necessary to accomplish the functional purpose of the article, and no person shall use any quantity of thermoplastics in the manufacture of decorative attachments for any article.

(c) *War use exemption.* Nothing contained in paragraph (b) (1) above shall apply to use of thermoplastics by the United States Army, Navy, Coast Guard, Maritime Commission or War Shipping Administration, or by any person pursuant to the terms of any contract or order for thermoplastics or articles made therefrom, where such thermoplastics or articles are to be delivered to, or incorporated into products to be delivered to, the aforesaid agencies, provided that such use is expressly made subject to war use exemption in Exhibit A annexed.

(d) *Existing stocks exemption.* Notwithstanding the provisions of paragraph (b) (1) above, any person may use, in the manufacture of any article set forth in Exhibit A annexed, thermoplastics which:

(1) Were in his possession prior to the effective date of restriction on such article, or

(2) Were in the possession of his thermoplastics supplier and on his purchase order had been so processed prior to the effective date of restriction on such article as to render impracticable their use in a manner not subject to restriction by this order.

(e) *Scrap exemption.* The provisions of paragraph (b) (1) above shall not apply to the use of scrap resulting from the processing or fabrication of thermoplastics: *Provided, however,* That no person shall use or deliver thermoplastics scrap resulting from his own operations unless:

(1) Such scrap is not of a quality to permit its reuse in the operation or product from which it was obtained, and

(2) The quantity of such scrap does not exceed 15 percent of the quantity of thermoplastics from which it was obtained.

(f) *Notification of customers.* Producers of thermoplastics shall as soon as practicable notify each of their regular customers of the requirements of this order and of all amendments hereto, but failure to receive such notice shall not excuse any such person from complying with the terms hereof.

(g) *Miscellaneous provisions*—(1) *Applicability of regulations.* This order and all transactions affected hereby are subject to all applicable provisions of War Production Board regulations, as amended from time to time.

(2) *Effect of other orders.* Nothing in this order contained shall be construed to permit the manufacture of any item or of units of any item if the manufacture of said item has been prohibited or curtailed by the terms of any other War Production Board order, heretofore or hereafter issued.

(3) *Reports.* Each person affected by this order shall file such reports as may from time to time be required by the War Production Board.

(4) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States, is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making, or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

(5) *Appeals.* Appeal from the provisions of this order shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

(6) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Chemicals Division, Washington, D. C., Ref: M-154.

Issued this 26th day of March 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

EXHIBIT A

Item	*Effective date of restriction*
Advertising and miscellaneous novelties.	Sept. 1, 1942
Amusement machines and parts..	Sept. 1, 1942
Animal feeding dishes and cups..	Mar. 26, 1943
Artificial fingernails............	Sept. 1, 1942
Artificial flowers, flower pots, and florists supplies, including plant markers.	Sept. 1, 1942
*Automobile accessories, but not including standard equipment	Mar. 26, 1943
Baby carriage parts............	Sept. 1, 1942
Baby rattles, teething rings and pacifiers.	Mar. 26, 1943
*Badges, emblems and campaign buttons, except the following: Personal identification required by governmental agencies, personnel and plant identification for industrial use, tags and badges required for tax purposes by state and municipal governments, public safety personnel of state and municipal governments.	Jan. 9, 1943
Barber shop lather dispensers....	Jan. 9, 1943
Bathroom fixtures:	
* Accessories, such as toothbrush holders, drinking cups, shower curtain hooks, etc., but not including plumbing parts and fixtures.	Jan. 9, 1943
Laundry hampers............	Sept. 1, 1942
*Soap dishes................	Sept. 1, 1942
*Toilet seats, all plastic.......	Sept. 1, 1942
*Toilet seats, plastic covered for private housing.	Jan. 9, 1943
*Towel bars (war use exemption for use on board ship only).	Sept. 1, 1942

*Subject to war use exemption. This exemption is subject to any specific limitations on war use exemption noted opposite particular items.

Item	Effective date of restriction
Beauty parlor equipment	Mar. 26, 1943
*Belts	Sept. 1, 1942
Beret bars	Mar. 26, 1943
Bill folds	Jan. 9, 1943
*Binoculars and opera glasses, and their parts.	Sept. 1, 1942
Bobby pins and barrettes	Mar. 26, 1943
Book covers and book marks	Mar. 26, 1943
Book ends and book stands	Sept. 1, 1942
*Bowls	Jan. 9, 1943
Broom fittings and dust pans	Sept. 1, 1942
Buttons and buckles, except for utility.	Mar. 26, 1943
Calendar holders	Mar. 26, 1943
Calendars	Jan. 9, 1943
Calling card cases	Mar. 26, 1943
Candle sticks	Sept. 1, 1942
Caskets, decorative parts	Sept. 1, 1942
Tips and lugs.	
Handles and caps.	
Corner pieces.	
Chime shields	Jan. 9, 1943
*Clock cases	Jan. 9, 1943
*Clock crystals	Mar. 26, 1943
Closet accessories	Sept. 1, 1942
Clothes hangers.	
Hat boxes.	
Hat stands.	
Shoe horns.	
Shoe trees.	
Tie racks.	
Clothes pins	Mar. 26, 1943
Coin banks and other coin holders	Jan. 9, 1943
Collars and cuffs (except for religious use).	Mar. 26, 1943
Combs	Sept. 1, 1942
Combination combs.	
*Combs with attachments.	
*Combs with plastic cases.	
Fancy side, back or tuck combs.	
*Containers, except closures, for pharmaceutical preparations in standard dosage forms, including but not limited to, pills, tablets, capsules and powders except for export use	Mar. 26, 1943
Cosmetic containers and accessories, except the following:	Jan. 9, 1943
Vanity cases or compacts of not more than two-inch diameter or two inches square; lipstick holders; or closures for cosmetic containers.	
Crumb scrapers	Mar. 26, 1943
*Curtain fixtures and window pulls (war use exemption for use on board ship only).	Mar. 26, 1943
Darning eggs	Mar. 26, 1943
Decorative plastic stitching	Jan. 9, 1943
Displays, including but not limited to:	Sept. 1, 1942
Advertising printing.	
Containers and packages, including all transparent boxes and food covers.	
Fixtures, mannequins and hosiery forms.	
*Signs and advertising sign letters.	
Door sills	Jan. 9, 1943
Dress spangles	Jan. 9, 1943
Eye wash cups	Mar. 26, 1943
*Food containers, except closures, adhesives and protective coatings for food containers.	Mar. 26, 1943
*Fruit juicers	Mar. 26, 1943
*Furniture, furniture parts, and upholstery except seat coverings for public transportation equipment.	Mar. 26, 1943
Games and toys	Jan. 9, 1943
Glass "shatterproofing" treatment, except laminated safety glass.	Mar. 26, 1943
*Glove fasteners	Sept. 1, 1942
Greeting cards and components	Jan. 9, 1943
Hair bands	Jan. 9, 1943
Hair curlers	Jan. 9, 1943
Handbags and components, except handbag cement and slide fasteners.	Sept. 1, 1942
Handbag frames	Mar. 26, 1943
*Handles for carpenter tools, except screw drivers and chisels.	Sept. 1, 1942
*Handle knobs for drawers and closets.	Mar. 26, 1943
*Hats and hat ornaments	Jan. 9, 1943
House address numbers	Mar. 26, 1943
Ice cube trays	Mar. 26, 1943
Jewelry and ornaments, including hand fabricated jewelry.	Mar. 26, 1943
Jewelry cases and watch boxes	Sept. 1, 1942
Jigger cups	Sept. 1, 1942
Lamp cord protectors	Mar. 26, 1943
*Lamp shades and bases, except industrial and office.	Mar. 26, 1943
*Laminations and covers to photographs and pictures.	Mar. 26, 1943
*Magnifying lenses	Mar. 26, 1943
*Match cases and boxes	Jan. 9, 1943
Medical instruments, non-professional.	Mar. 26, 1943
Throat lights.	
Tongue depressors.	
Millinery	Sept. 1, 1942
Musical instruments—decorative parts.	Sept. 1, 1942
*Nameplates, but not including equipment, data and instruction plates.	Sept. 1, 1942
Napkin rings	Sept. 1, 1942
*Pass cases, other than for industrial or governmental identification.	Jan. 9, 1943
Pencils, novelty	Jan. 9, 1943
Pharmaceutical pill, tablet and capsule trays.	Mar. 26, 1943
*Phonograph or auto radio receivers and parts.	Mar. 26, 1943
*Photographic equipment and supplies.	Mar. 26, 1943
*Picture and mirror frames	Sept. 1, 1942
*Pistol grips and rifle butts, except for governmental use.	Mar. 26, 1943
Place card holders	Jan. 9, 1943
Placques and laminated placques	Jan. 9, 1943
Plastic book binding—comb or spiral type for advertising, promotional, premium, recreational or novelty products.	Jan. 9, 1943
*Playing cards	Jan. 9, 1943
*Pocket and scout knives	Mar. 26, 1943
Poker chips	Jan. 9, 1943
Poker chip holders	Mar. 26, 1943
Premium items	Sept. 1, 1942
Price tags, except for meat and dairy products.	Jan. 9, 1943
*Protective envelopes and laminations to paper for other than documents, permanent records, blueprints and industrial charts.	Mar. 26, 1943
Ration book cases	Jan. 9, 1943
*Razor boxes	Sept. 1, 1942
*Razor sharpeners	Jan. 9, 1942
Restaurant and coin operated phonograph parts.	Sept. 1, 1942
*Salt and pepper shakers and tops	Sept. 1, 1942
*Scales, except for industrial and commercial use.	Mar. 26, 1943
Sculptured pieces	Sept. 1, 1942
Seasonal ornaments and ornamental lighting fixtures.	Sept. 1, 1942
Sewing thread spool holders	Mar. 26, 1943
*Serving trays, except for cafeterias, restaurants and hospitals.	Jan. 9, 1943
*Shaving brush containers	Mar. 26, 1943
Shoe heels, except plastic coated	Sept. 1, 1942
Shoe trimmings	Jan. 9, 1943
Shoe uppers, woven	Sept. 1, 1942
*Ski goggles	Mar. 26, 1943
Sleeve protectors	Mar. 26, 1943
Smokers' supplies:	
Ash trays	Sept. 1, 1942
*Cigarette and cigar holders, boxes and cases.	Sept. 1, 1942
Cigarette lighters	Mar. 26, 1943
Cigarette lighter flint containers.	Mar. 26, 1943
Pipe cases	Sept. 1, 1942
Soda fountain and beverage dispensing accessories.	Sept. 1, 1942
Beer scrapers.	
Beverage stirrers.	
Drinking straws.	
*Faucet handles and knobs (war use exemption use on board ship only).	
*Soap containers	Mar. 26, 1943
*Sporting goods, except ping pong balls for Red Cross.	Mar. 26, 1943
Stationery supplies:	
Desk sets	Jan. 9, 1943
Envelope openers	Mar. 26, 1943
Ink stands	Jan. 9, 1943
Ink wells	Jan. 9, 1943
Moisture applicators, except sealing tape machines.	Mar. 26, 1943
Paper clips	Mar. 26, 1943
Pen bases and holders	Mar. 26, 1943
Pencil sharpeners	Mar. 26, 1943
Rulers, but not including edge strips for rulers.	Mar. 26, 1943
Stapling machines	Mar. 26, 1943
*Storm sash and windows	Jan. 9, 1943
*Sun goggles, except for use with corrective lenses.	Mar. 26, 1943
Syphons for carbonated water	Sept. 1, 1942
Syrup dispensers	Mar. 26, 1943
Table mats, coasters and table ornaments.	Sept. 1, 1942
*Tableware — cups, saucers, plates, tumblers, knives, forks, spoons, except handles for knives, forks, spoons.	Mar. 26, 1943
*Tableware cases and boxes	Sept. 1, 1942
Toilet sets, except three-piece sets of mirror, brush and comb.	Sept. 1, 1942
*Toothbrush containers	Mar. 26, 1943
*Travelling bags, baggage and handles therefor.	Sept. 1, 1942
Umbrella and parasol handles	Sept. 1, 1942
Vending machines and parts	Mar. 26, 1943
*Visors, except industrial	Mar. 26, 1943
Wall shields	Mar. 26, 1943
Window lifts	Jan. 9, 1943

NOTE.—Where a specific item previously included in a general heading is added for purpose of clarification, the governing date of restriction on such item is the effective date of the restriction on the general heading.

Mechanical properties of plastics at normal and subnormal temperatures*

by T. P. OBERG,† R. T. SCHWARTZ,† and D. A. SHINN†

Summary

IN THE development of new high strength plastic materials for possible application in primary aircraft structures, which is now being strongly emphasized, it should be noted that balanced tensile, compressive and shear properties are necessary. High elastic properties, modulus of elasticity, proportional limit and yield strength practically comparable in tension and compression are desired, the ultimate strengths in tension and compression being secondary. The shear strength and shear rigidity are also important. The present investigation is concerned with the determination of the static tensile, compressive, stiffness and bending properties, and the fatigue characteristics of a number of thermoplastic and thermosetting plastic materials at temperatures of −38°, 0° and +78° F.

The specific gravity of the materials covered by this investigation ranged from 0.54 for plastic-bonded plywood to 1.38 for compressed, resin-bonded, laminated wood. The laminated phenolic thermosetting plastics, paper and fabric bases, the resin-bonded plywood and the resin-bonded laminated wood, both compressed and natural or non-compressed, developed the higher specific strengths, with low elongation. In general, it was found that with decreasing temperature the static strength properties, modulus of elasticity, proportional limit, yield strength and ultimate strength increase, and the elongations and impact strengths decrease. This effect is very marked for thermoplastic materials and there is much less effect on thermosetting plastics, the ultimate strength increasing only slightly. Plastic-bonded wood is also very little affected by low temperatures.

The data on fatigue properties, although somewhat limited for some of the materials, indicate that plastics in general are not adversely affected by low temperatures. The thermoplastic materials showed a greater increase in fatigue strength at low temperature than the thermosetting plastics. The latter are affected by notches at normal temperatures but the former are not.

The mechanical properties of the materials are given in tabular form and stress-strain curves are also presented. The data are presented for consideration and study especially with reference to their use in design. It is recognized that developments are constantly in progress in the plastics field but it is believed that the data herein indicate the general trend for each specific type of plastic.

* Abridged from Air Corps Technical Report No. 4648.
† Materials Laboratory, Army Air Forces, Matériel Center.

Materials tested

Several types of thermoplastic and thermosetting plastic materials as well as plastic-bonded plywood and resin-impregnated, compressed laminated wood were tested. A list of these, including specific gravity and description, is given in Table I. The materials were procured either from Wright Field stock or on the open market. They represented the latest types available at the time and conformed to applicable specifications, except 0.5-in. cellulose acetate sheet, which was experimental. The letters "A" and "B" are used to differentiate between materials of the same type but of different sources or composition and are not to be construed as commercial designations.

TABLE I.—DESCRIPTION OF PLASTIC MATERIALS

Type	*Specific gravity*	*Description*
THERMOPLASTIC PLASTICS		
Vinyl chloride acetate copolymer "A"	1.35	Transparent sheets, purplish cast
Vinyl chloride acetate copolymer "B"	1.34	Transparent sheet, water white
Polyvinyl acetal	1.10	Transparent sheet, purplish cast
Cellulose acetate "A"	1.28	Transparent sheets, yellowish tint. Air Corps Specification 12025-B
Cellulose acetate "B"	1.30	Transparent sheet, water white. Obtained from stock. Air Corps Specification 12025-B
Cellulose acetate butyrate	1.20	Transparent sheet
Polystyrene "A"	1.05	Injection molded transparent sheet, water white
Polystyrene "B"	1.05	Injection molded, 0.5-in. square rod, water white
Methyl methacrylate "A"	1.18	Cast transparent sheet, water white. U. S. Army Specification 94-12014-B
Methyl methacrylate "B"	1.18	Same as "A" but different source of supply. Probably same manufacturer. U. S. Army Specification 94-12014-B
THERMOSETTING PLASTICS		
Cast phenolic	1.36	Cast phenol-formaldehyde sheet. Transparent amber

(*Please turn to next page*)

TABLE I.—DESCRIPTION OF PLASTIC MATERIALS (*Continued*)

Type	Specific gravity	Description
THERMOSETTING PLASTICS		
Laminated phenolic "A," Grade L	1.34	Sheet, fabric base, laminated, phenol-formaldehyde resin. Woven fabric cloth less than 8 oz. per sq. yd. Obtained from stock. U. S. Army Specification 71-484
Laminated phenolic "B"		
Grade L	1.34	Sheet, fabric base, woven fabric cloth less than 8 oz. per sq. yd. U. S. Army Specification 71-484
Grade C	1.34	Sheet, fabric base, woven fabric cloth exceeding 8 oz. per sq. yd.
Grade XX	1.34	Sheet, paper base; 50 percent resin content
RESIN-BONDED PLYWOOD AND LAMINATED WOOD		
3/16-in. mahogany-mahogany plywood	0.64	3-ply, polyvinyl butyral bonded. Taken from skin of wing section. 7.1 percent moisture content
3/16-in. mahogany-poplar plywood	0.54	3-ply, phenol-formaldehyde resin bonded. Same type as used on aircraft. 4.0 percent moisture content. Army-Navy Specification AN-NN-P-511
1/8-in. mahogany-poplar plywood	0.54	3-ply, 1/16-in. poplar core. Phenol-formaldehyde resin bonded. Type used as skin on aircraft. 4.0 percent moisture content. Army-Navy Specification AN-NN-P-511
Impregnated, 50 percent compressed, laminated maple 1/16-in. plies		
Panel A	1.29	Low resin content; 3.5 percent moisture
Panel D	1.37	High resin content; 3.1 percent moisture
Panel E	1.38	No impregnation, resin-paper bond; 1.6 percent moisture
Resin-bonded, non-compressed, laminated maple, 1/8-in. plies, Panel G	0.68	No impregnation, resin-paper bond; 3.3 percent moisture
Impregnated, compressed laminated birch, 0.08-in. plies	1.12	Phenolic-resin impregnated and bonded; 4.4 percent moisture content
Natural birch	0.69	7.0 percent moisture content. Propeller grade stock
Natural maple, hard	0.70	8.0 percent moisture content

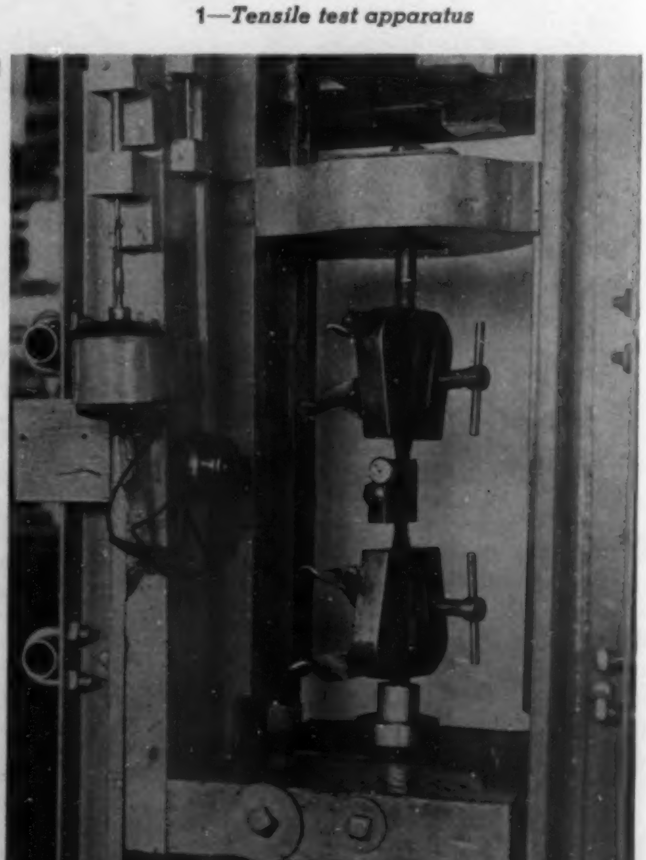
Procedure for static tests

General—Olsen screw-type, lever weighing, universal testing machines with ranges of 2000 and 20,000 lb. were used for most tensile, compressive and bend tests at both normal and subnormal temperatures. A few tensile tests at normal temperatures were made in an Amsler 20,000-lb. hydraulic machine for the purpose of obtaining load-strain curves with a Templin autographic recorder. The 2000-lb. range was used on the Olsen machine except for 0.5-in. thick tensile specimens which required the 20,000-lb. scale. An Olsen stiffness tester, originally 5 in.-lb. capacity but increased to a capacity of 22 in.-lb., was used for the stiffness testing.

Deformation readings were taken at equal increments of load. The hand wheel drive was used to apply load slightly past the 0.2 percent offset yield strength. The deformation was read immediately on reaching a given load. After removing the strain or dial gage, the specimen was then loaded to fracture at the slowest speed available employing the motor drive, which was 0.14 in. per min. head travel under no load, on the testing machine in the low temperature room. The demand for other types of tests in the low temperature room necessitated the use of a similar Olsen machine in the laboratory for the majority of tests at room temperature. The rate of head travel in this machine was 0.10 in. per minute. However, the following tests were made in the Olsen machine in the cold room but at room temperature: tension, bend and compression on methyl methacrylates, and tension on cellulose acetates, cellulose acetate butyrate, laminated phenolic "A," polyvinyl acetal and vinyl chloride acetate copolymer "B."

All specimens tested at normal temperature except the impregnated laminated wood were conditioned for at least 48 hr. at 75° F. ± 1° F. and 50 ± 5 percent relative humidity and tested immediately after removal from the conditioning atmosphere. The material tested at low temperatures was held at least 24 hr. at the desired temperature before testing. The low temperature work at 0° and −38° F. was done in the refrigerated testing chamber of the Materials Laboratory. No controlled temperature and humidity room for normal tem-

1—*Tensile test apparatus*

1


peratures was available. The room temperature tests were made at 78° F. ± 2° F. and the relative humidity varied from 35 to 50 percent, over the period of time covered by this investigation.

Load-deformation data were converted to stress-strain and plotted. The slope of the straight line portion of the curve was taken as the modulus of elasticity. The yield strength was determined by drawing a line parallel to the initial straight line portion of the curve and at an offset of 0.002 in. per inch. The stress corresponding to the point where this straight line intersects the stress-strain curve is the yield strength. The proportional limit at 0.01 percent offset was obtained similarly. The tangent proportional limit was obtained by inspection as the point where the straight line portion of the stress-strain diagram was tangent to the curved portion. The above procedures correspond to those customary for metals, described in Federal Specification QQ-M-151.

Dimensions of specimens were measured at room temperature with standard micrometers.

Tensile testing—The tensile specimens were made according to Federal Specification L-P-406 (reference 19). The specimens were at first cut out with a router in the wood shop but later were machined out by cross-milling with a form cutter having a contour of the reduced cross section of the specimen.

Templin self-aligning grips were used for all tests except for specimens of greater than 0.25-in. thickness, for which the standard wedge grips in the heads of the testing machines were used. Emery cloth was used over the ends of the specimens, to reduce slipping in the grips. An Olsen Last Word strain gage, 2-in. gage length, was employed for deformation measurement. The smallest division on this dial represents 0.0001-in. deformation or 0.00005 in. per in. strain. A specimen in the Templin grips with the strain gage attached is shown in Fig. 1. The length of specimen between the edges of the grips was approximately 4.25 inches. The average rate of head travel under load during hand loading was approximately 0.01 in. per min. for thermoplastic materials, and 0.004 in. per min. for thermosetting plastics and wood. This difference in straining rate was due to the fact that the average time required for each increment of stress was approximately the same, regardless of strain. The lower elastic properties of the thermoplastics thus account for the higher rate. After load deformation readings to slightly beyond the yield strength were obtained by hand loading, the strain gage was removed and the specimen loaded to fracture using the friction drive, giving the slowest head-travel available, 0.14 in. per minute. The Olsen strain gage was adjusted carefully for every thickness of specimen to insure satisfactory holding and at the same time produce a minimum marking effect due to the knife edges. Each specimen was marked for 2-in. gage lengths, using a marking device with ruling pen and India ink, to avoid scratches and punch marks.

Elongation was followed up to fracture on the 2-in. gage length (after removal of the strain gage, if data were desired for a stress-strain curve), using a pair of dividers. Elongation was also taken 2 hr. after fracture. This time was chosen as a matter of convenience. Elongation measurements were made to the nearest 1 percent. At least two specimens of each plastic were tested for determination of stress-strain properties at each temperature. At least two additional specimens were tested to fracture without the strain-gage, using the friction drive in order to ascertain if the hand-loading period or knife-edge markings had any effect on the ultimate strength and elongation. Additional specimens were tested in those cases where appreciable variation in results were encountered.

2

2—Olsen stiffness tester with plastic specimen in place during test

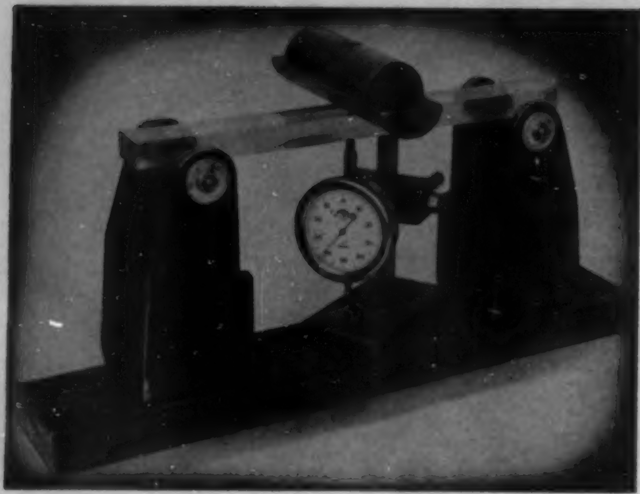
However, only two specimens each of cellulose acetate butyrate, polyvinyl acetal and vinyl chloride acetate copolymer "B" were tested at low temperature, because of a limited amount of material.

Two specimens of 0.188-in. methyl methacrylate were tested in tension, employing Tuckerman optical strain gages, 1-in. gage lengths, for checking the modulus of elasticity obtained with the Olsen gage.

Stiffness tests—Stiffness specimens were 0.5 by 4 in. by the thickness of the sheet. In Fig. 2, a specimen is shown in place during test in the Olsen stiffness tester. The specimen was tested as a cantilever beam on a 2-in. span. At room temperature the motor drive was used, the loading being continuous to failure or to 90° bend, which is the maximum range of the machine. The percent load was read corresponding to intervals on the deformation scale graduated in degrees. At low temperatures the load was applied using the hand crank approximating the speed of the motor, because the latter could not be used without changing oil or grease. The amount of weights used was determined by trial so that nearly the full range of the percent load scale was employed. The pointer on the deflection scale was adjusted to zero at zero percent load with the specimen touching the loading device. At least three specimens of each type were tested at each temperature. A ball-bearing hanger for extra weights was employed to increase the capacity of the machine to 22 inch-pounds.

Bend or beam tests—Bend tests were made using the simple beam set-up shown in Fig. 3. The end supports are 0.25-in. diameter steel pins in ball bearings and the span length is adjustable. The loading was done with a 1.375-in. diameter brass cylinder. The span length was approximately 16 times the thickness, as this has been found satisfactory for wood in order to render deflections due to shear negligible. The specimen width was 1 inch. Load-deformation readings were

3



3—Bend test jig

taken past the elastic limit, the dial removed and the specimen run to failure. An Ames dial graduated in 0.001 in. was used to measure deformation at the center and was located under the specimen. At least two specimens were run to secure load-deformation data, at rate as noted above, and two additional specimens were tested to failure using the friction drive only, corresponding to procedure in tension tests.

Compression tests—Compression tests were made in a special compression jig consisting of a hardened steel plunger and spherical seat in a cast-iron holder to eliminate any effects of unequal loading or movement of testing machine heads. The specimens were 0.5 × 0.5 × 2 in., having a slenderness ratio of 13.8. Paired 1-in. gage length Tuckerman optical strain gages were used. The set-up is shown in Fig. 4.

Specific gravity—Specific gravity was obtained by weighing specimens whose volumes were determined by measurements made with standard micrometers.

Procedure for fatigue tests

The fatigue tests were conducted in ball-bearing rotating-beam fatigue machines at normal temperature and in the cold chamber at −30° F. The temperature during the fatigue tests fluctuated between −30° F. and −35° F. The operating speed of the fatigue machines at subnormal temperature was 3450 r.p.m. and at normal temperature was either 3450 or 10,600 r.p.m. The heat generated by the ball bearings is small compared to ordinary bearings; the temperature differential from the bearings to the specimen did not exceed 5°. The specimens were kept in the cold chamber at the desired temperature for at least 12 hr. before test.

The dimensions of the rotating-beam fatigue specimens are shown in Federal Specification L-P-406 (reference 19). The notched fatigue specimen has been used to compare the notch sensitivity of metallic materials in this laboratory. Specimens were from thermosetting phenolic material, reinforced with fabric or paper, both parallel and transverse to the length of the sheet. Specimens cut from laminated (parallel-grain) panels, maple and birch, impregnated and bonded with phenolic resin, were machined parallel to the grain.

Specimens machined from the thermoplastics and cast phenolic material were polished with a cleaner and polishing compound for transparent sheet. Those machined from wood and reinforced phenolic materials were polished successively with fine sandpaper and No. 1, 0 and 00 emery paper. To polish a rotating beam fatigue specimen, it was placed in a lathe on centers and rotated at a speed of approximately 600 r.p.m. The specimen while rotating was polished using a light motor at 1700 r.p.m., having an extension shaft to which the emery paper is fastened by a slotted piece and held perpendicular to longitudinal axis of specimen (Fig. 5).

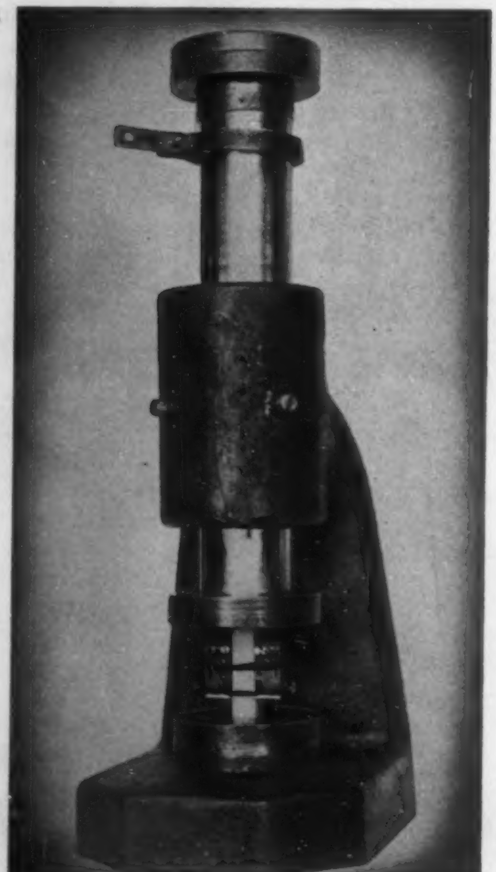
Procedure for impact tests

The specimen for the impact test conformed to Federal Specification L-P-406 (reference 19). An Olsen Izod cantilever beam pendulum type testing machine was used; scale ranges were 25, 50 and 100 inch-pounds. The composite specimens made up of laminations were accurately aligned with the laminations in close contact. The notch on these specimens was on the edge. Some solid specimens were tested notched on edge. The impact strength in ft.-lb. per in. of notch was determined by dividing the energy in ft.-lb. by the actual dimension in inches along the notch of the specimen. Five specimens were tested for each condition. Conditioning of impact specimens for room temperature tests was 96 hr. at 77° ± 2° F. and 50 ± 2 percent relative humidity. For tests at −38° F., specimens were conditioned 24 hr. at that temperature.

Discussion

General—Considerable variation in the values of the mechanical properties of plastics may be expected if testing

4



4—Compression test jig

conditions are varied. Some of the variable factors are: temperature, humidity, rate of loading, form of specimen and previous history of the material. Variations occur in properties between different lots or sheets of the same material due to unavoidable differences in manufacture, such as variation in composition, degree of polymerization and aging. In this investigation the methods used in testing were con-

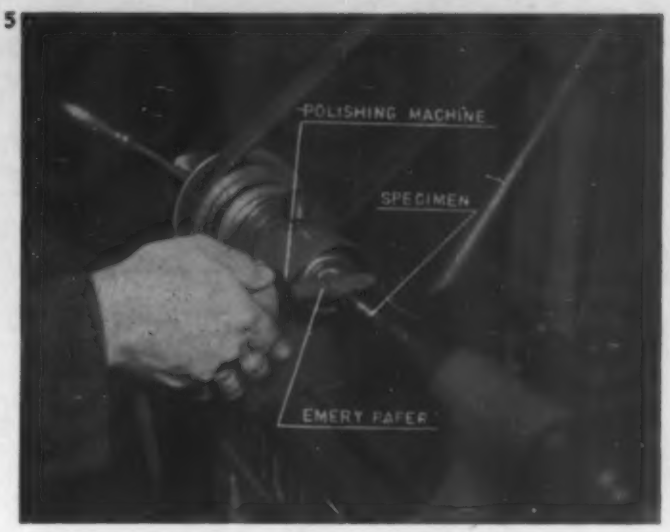
trolled by the type of testing machine available in the low temperature testing room. The test points for the static loadings are not plotted as the curves were traced from the original plottings.

Specimens—The tensile specimen used is similar to the standard flat specimen for metals, Fig. 5 in Federal Specification QQ-M-151a, except for the larger radius at the shoulders. It was found that this specimen was convenient for standard strain-gage and elongation measurements and that failures in general occurred in the reduced section. The dimensions of the compression specimens, 0.5 × 0.5 × 2 in., were taken in order to secure a slenderness ratio comparable to that used for metals and wood. Since 2 in. are necessary to provide attachment and clearance for the 1-in. strain-gages, specimens could be obtained only from 0.5-in. sheet. The "pack" method of compressive testing (reference 2) may offer a satisfactory procedure but time was not available to study its applicability.

All specimens of a given thickness of material were taken from the same sheet, except in the case of 0.1-in. polystyrene and cast phenolic material, from which the specimens had to be taken from several pieces. Specimens were taken in both longitudinal and transverse directions for the laminated phenolic material since the properties varied with direction. Only longitudinal specimens (parallel to face grain) were taken from the plywood and laminated wood, since the strength normal to the grain is relatively low. The specimens for the remainder of the material were all longitudinal with the sheet. However a few specimens of acrylate and cellulose acetate taken transversely showed no difference in properties from longitudinal. The fatigue specimens used were found to be satisfactory for testing in rotating-beam fatigue machines and all failures occurred in the gage section.

Rate of head travel—The dependence of results on rate of loading arises from the fact that plastics show a deformation under stress which is dependent on the time of application. Even at very low values of stress, a plastic deformation which is dependent on the time of application is exhibited (reference 3). This present investigation, however, was confined to short-time tests where these effects are minimized. The load-deformation data were taken only far enough to secure the 0.2 percent offset yield strength, and this was usually in the range of 1 to 2 percent total elongation. In this range the effect of variation in rate of straining within the limits in

5



5—*Polishing fatigue specimen*

which the deformation readings may be conveniently taken is not great. However, in testing plastics by the hand loading procedure, the rate of straining was kept as nearly constant as possible in order to insure consistent results. The results obtained by the procedures described were reproducible at all the test temperatures.

Variation in rate of straining has a great effect on the ultimate strengths and elongation; in general, higher rates increase the ultimate strength and decrease the elongation. Limited tests indicate that the effect is less as the temperature is lowered and the material becomes less plastic. Thermosetting plastics are affected less than thermoplastics.

It was found that the period of hand-loading for obtaining the load-deformation data had no effect on the ultimate strength and elongation, the values obtained by fracturing the specimens after removal of the gage being the same as those obtained by testing for ultimate strength only for which no gage was used.

Tensile tests for comparative purposes were made at room temperature on cellulose acetate, methyl methacrylate, laminated phenolic and plywood on the two Olsen testing machines, and no consistent difference in the average tensile strength and elongation was observed for these materials, although the head travel rates were 0.14 in. per min. for the

6

6—*Effect of temperature on tensile strength and elongation of plastics*

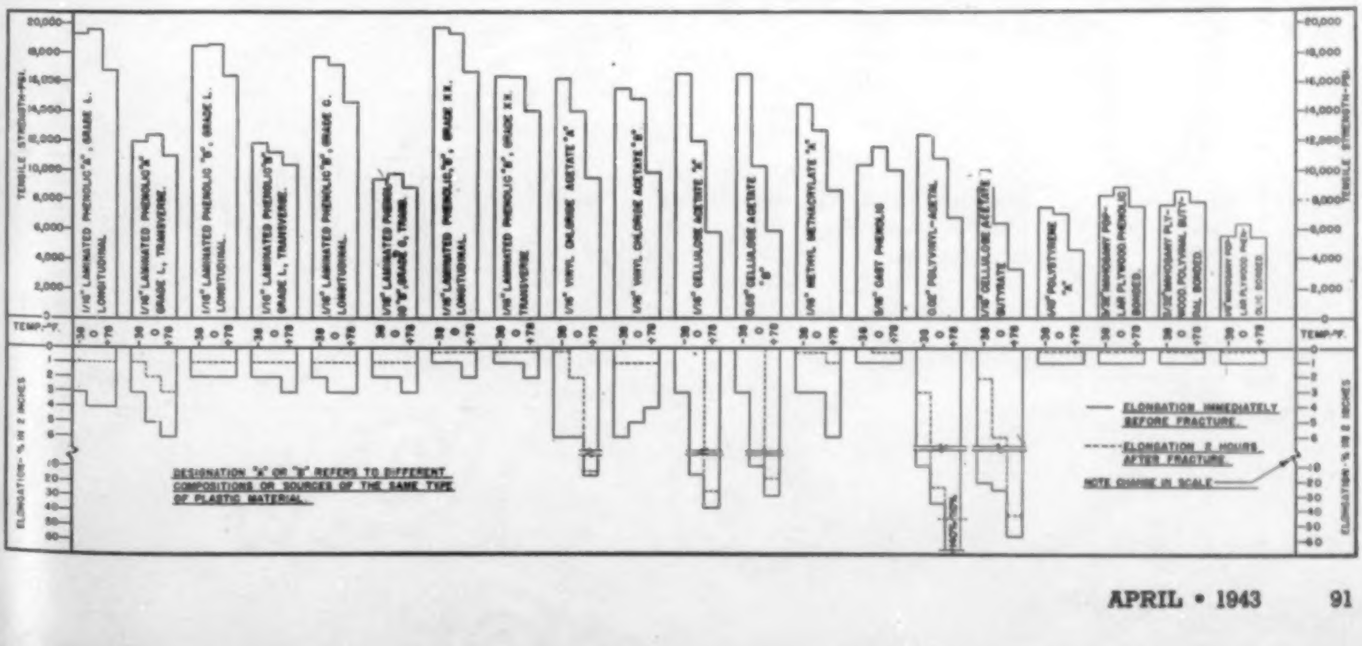


Table II.—Tensile Properties of Plastics at Various Temperatures[a]

Temperature, ° F.	Relative humidity, %	Nominal thickness, In.	Modulus of elasticity, p.s.i.	Proportional limit, tangent, p.s.i.	Proportional limit, 0.01% offset, p.s.i.	Yield strength, 0.2% offset, p.s.i.	Ultimate strength, p.s.i.	Elongation in 2 in gage length, %		Average deviation from mean ultimate strength, %	Vickers pyramidal hardness, 2.5-kg. load	Tensile strength divided by specific gravity
								Before fracture	After 2 hr.			
VINYL CHLORIDE ACETATE COPOLYMER "A"												
78	40	1/16	446,000	2700	3100	6,490	9,580	16	13	1.4	16.0	7,100
78	40	1/8	460,000	2000	2500	6,130	9,400	35	30	1.2	16.0	6,960
0	..	1/16	502,000	4000	4400	8,900	14,070	6	2	0.6	...	10,420
0	..	1/8	534,000	2000	2500	7,790	14,260	9	5	0.3	...	10,560
−38	..	1/16	540,000	5300	5700	10,050	16,260	6	..	0.2	...	12,030
−38	..	1/8	583,000	3300	3700	8,440	16,700	4	..	0.1	...	12,370
VINYL CHLORIDE ACETATE COPOLYMER "B"												
78	50	0.04	426,000	5500	6000	7,600	9,910	4	1	2.6	16.9	7,390
0	..	0.04	528,000	5500	6000	10,000	14,820	5	1	0.3	...	11,060
−38	..	0.04	519,000	6300	6500	10,000	15,550	6	1	1.0	...	11,600
POLYVINYL ACETAL												
78	50	0.02	230,000	3800	4400	5,450	6,830	140	110	6.0	12.0	6,210
0	..	0.02	360,000	4500	5000	7,470	10,860	35	23	1.3	...	9,870
−38	..	0.02	400,000	5000	5300	7,840	12,400	10	3	0.0	...	11,280
CELLULOSE ACETATE "A"												
78	50	1/16	217,000	2100	2200	3,600	5,860	38	27	3.6	10.1	4,570
78	50	1/8	222,000	1600	1700	2,900	5,620	42	30	4.2	10.5	4,390
78	50	1/2	....	...	...	...	3,900	40	28	2.0	8.3	3,050
0	..	1/16	433,000	2700	3300	6,050	12,040	15	..	1.2	...	9,420
0	..	1/8	392,000	2000	2200	5,250	10,650	14	1	0.9	...	8,320
−38	..	1/16	630,000	4000	4300	8,150	16,600	3	..	2.4	...	12,960
−38	..	1/2	620,000	3400	3700	7,760	15,450	3	..	3.7	...	12,060
CELLULOSE ACETATE "B"												
78	35	0.03	208,000	2900	3000	3,800	5,910	30	18	8.9	11.8	4,540
0	..	0.03	383,000	3600	4000	6,700	10,360	10	.	1.6	...	7,970
−38	..	0.03	735,000	4600	5000	10,400	16,560	3	..	1.4	...	12,750
CELLULOSE ACETATE BUTYRATE												
78	45	1/16	117,000	1500	1550	2,100	3,300	57	42	3.3	5.0	2,750
0	..	1/16	214,000	1600	1800	3,500	6,410	25	6	3.4	...	5,340
−38	..	1/16	310,000	1700	2000	4,000	8,900	20	2	0.0	...	7,520
POLYSTYRENE "A"												
78	40	1/16	469,000	2100	2500	4,700[b]	4,700	1	<1	13.0	20.6	4,470
0	..	1/16	536,000	2400	2800	6,100[c]	7,100	1	<1	10.4	...	6,760
−38	..	1/16	554,000	3100	3700	6,300[c]	7,600	1	<1	5.6	...	7,240
METHYL METHACRYLATE "A"												
78	50	1/16	379,000	3300	3600	5,600	8,600	5	1	0.5	18.9	7,290
78	45	3/16	383,000	1600	1900	4,500	7,600	6[d]	1[d]	2.9	17.9	6,440
78	50	1/2	380,000	2200	2700	4,700	7,670	4	<1	0.7	18.0	6,500
0	..	1/16	521,000	3300	3600	7,600	12,740	3	<1	1.8	...	10,800
0	..	3/16	534,000	2300	2400	6,700	12,790	3	<1	1.7	...	10,830
−38	..	1/16	637,000	3600	3900	8,600	14,500	3	<1	2.4	...	12,290
−38	..	3/16	660,000	2500	2700	7,700	14,400	3	<1	7.8	...	12,200
METHYL METHACRYLATE "B"												
78	50	1/16	358,000	2600	2900	4,970	7,890	6	1	1.3	19.0	6,690
78	50	1/8	390,000	1800	2000	4,660	8,070	6[d]	1[d]	0.4	17.9	6,840
78	50	1/2	380,000	1800	2300	4,940	8,280	4	<1	0.6	17.1	7,020
0	..	1/16	535,000	2600	2900	6,900	13,450	3	<1	1.2	...	11,400
0	..	1/8	550,000	2000	2200	6,600	13,160	3	<1	0 4	...	11,150

Table II.—Tensile Properties of Plastics at Various Temperatures[a]—*Continued*

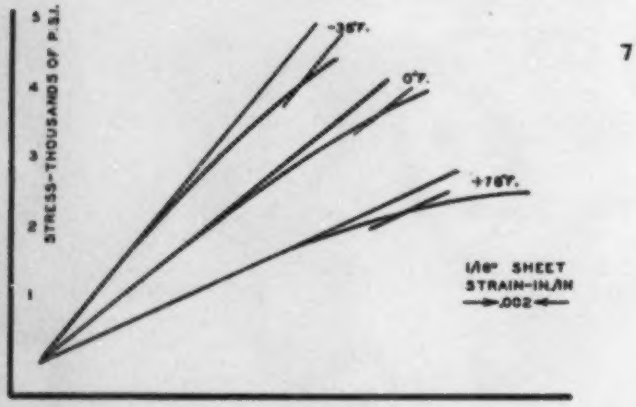
Temperature, °F.	Relative humidity, %	Nominal thickness, In.	Modulus of elasticity, p.s.i.	Proportional limit, tangent, p.s.i.	Proportional limit, 0.01% offset, p.s.i.	Yield strength, 0.2% offset, p.s.i.	Ultimate strength, p.s.i.	Elongation in 2 in. gage length, %: Before fracture	Elongation in 2 in. gage length, %: After 2 hr.	Average deviation from mean ultimate strength, %	Vickers pyramidal hardness, 2.5-kg. load	Tensile strength divided by specific gravity
CAST PHENOLIC, NON-REINFORCED												
78	35	5/16	....	...	...	...	10,040	1	<1	10.9	28.0	7,380
0	..	5/16	....	...	...	...	11,650	1	<1	4.0	...	8,570
−38	..	5/16	....	...	...	...	10,410	1	..	1.2	...	7,650
LAMINATED PHENOLIC "A," GRADE L, LONGITUDINAL												
78	40	1/16	1,210,000	3400	4000	8,000	16,800	4	1	0.9	33.5	12,530
0	..	1/16	1,535,000	3800	4200	9,670	19,600	4	1	2.0	...	14,620
−38	..	1/16	1,860,000	4000	4500	12,100	19,260	3	1	3.7	...	14,360
LAMINATED PHENOLIC "A," GRADE L, TRANSVERSE												
78	40	1/16	915,000	3000	3500	6,700	11,120	6	3	2.0	33.5	8,290
0	..	1/16	1,210,000	3000	3500	7,700	12,500	5	2	1.4	...	9,330
−38	..	1/16	1,410,000	4000	4500	8,860	12,010	3	1	3.1	...	8,960
LAMINATED PHENOLIC "B," GRADE L, LONGITUDINAL												
78	40	1/16	1,340,000	3100	3700	9,230	16,460	2	1	1.9	35.8	12,280
78	40	1/8	1,600,000	1900	2800	8,625	18,880	2	1	1.5	40.0	14,090
78	40	1/2	....	...	...	...	17,030	2	1	4.0	37.9	12,700
0	..	1/16	....	...	...	...	18,620	2	1	0.6	...	13,880
−38	..	1/16	1,705,000	6600	7200	14,350	18,540	2	1	1.1	...	13,830
LAMINATED PHENOLIC "B," GRADE L, TRANSVERSE												
78	40	1/16	928,000	2800	3400	6,760	10,460	3	1	0.2	35.8	7,800
78	40	1/8	1,110,000	1600	2400	6,570	12,530	3	1	0.4	40.0	9,340
78	40	1/2	....	...	...	...	12,330	2	1	0.8	37.9	9,190
0	..	1/16	....	...	...	...	11,300	2	1	0.4	...	7,690
−38	..	1/16	1,275,000	4500	5100	10,200	11,650	2	1	2.6	...	8,690
−38	..	1/8	1,290,000	4900	5900	11,200	14,140	2	1	1.5	...	10,550
LAMINATED PHENOLIC "B," GRADE C, LONGITUDINAL												
78	40	1/16	1,310,000	2200	3200	8,100	14,920	3	1	3.2	38.3	11,130
78	40	1/8	1,230,000	2600	3700	8,150	14,730	2	1	1.7	37.5	10,970
78	40	1/2	....	...	...	...	14,700	2	1	2.7	34.2	10,960
0	..	1/16	....	...	...	...	17,190	3	1	2.8	...	12,830
−38	..	1/16	1,730,000	5900	7500	14,800	17,730	2	1	2.0	...	13,220
LAMINATED PHENOLIC "B," GRADE C, TRANSVERSE												
78	40	1/16	967,000	2300	2900	6,240	8,910	3	1	5.2	38.3	6,640
78	40	1/8	1,002,000	2300	3300	6,620	9,600	2	1	1.0	37.5	7,160
78	40	1/2	....	...	...	...	9,870	2	1	3.7	34.2	7,360
0	..	1/16	....	...	...	...	9,840	2	1	0.9	..	7,340
−38	..	1/16	1,330,000	3700	4600	9,080	9,450	2	1	1.7	...	7,050
LAMINATED PHENOLIC "B," GRADE XX, LONGITUDINAL												
78	40	1/16	1,565,000	4100	6600	13,680	16,770	2	<1	3.0	40.0	12,510
78	40	1/8	1,643,000	3800	5500	11,850	16,700	2	<1	4.2	41.0	12,460
78	40	1/2	....	...	...	...	16,130	2	<1	0.9	38.9	12,030
0	..	1/16	....	...	...	...	19,350	1	<1	1.0	...	14,430
−38	..	1/16	2,135,000	8000	9400	17,700[c]	19,780	1	<1	1.9	...	14,750
LAMINATED PHENOLIC "B," GRADE XX, TRANSVERSE												
78	40	1/16	1,365,000	3400	5100	11,650	14,040	2	<1	1.9	40.0	10,470
78	40	1/8	1,310,000	3000	4400	10,280	14,550	2	<1	1.7	41.0	10,860
78	40	1/2	....	...	...	...	13,730	2	<1	3.0	38.9	10,240
0	..	1/16	....	...	...	...	16,360	1	<1	1.6	...	12,200
−38	..	1/16	1,830,000	6600	7800	14,900[c]	16,380	1	<1	2.0	...	12,220

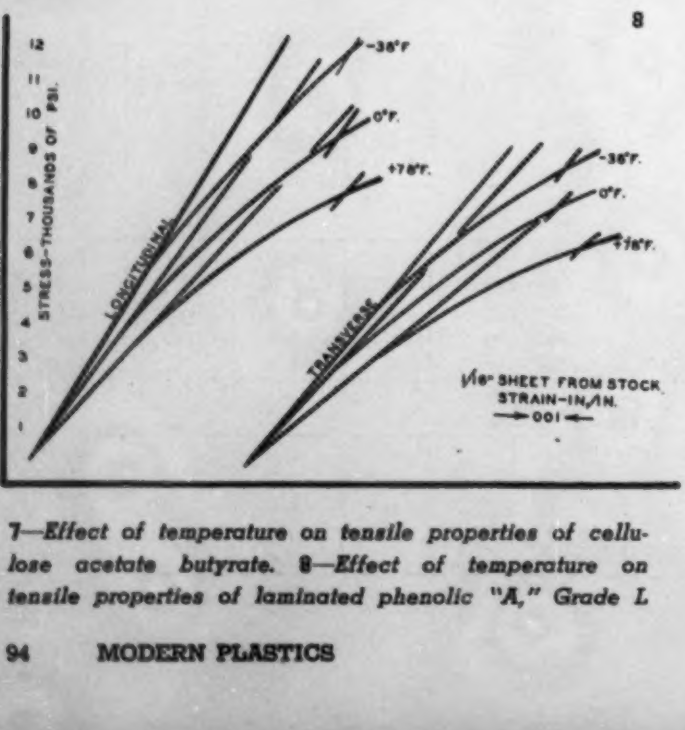
(*Please turn to next page*)

Table II.—Tensile Properties of Plastics at Various Temperatures[a]—Continued

Temperature, °F.	Relative humidity, %	Nominal thickness, In.	Modulus of elasticity, p.s.i.	Proportional limit, tangent, p.s.i.	Proportional limit, 0.01% offset, p.s.i.	Yield strength, 0.2% offset, p.s.i.	Ultimate strength, p.s.i.	Elongation in 2 in. gage length, % — Before fracture	Elongation in 2 in. gage length, % — After 2 hr.	Average deviation from mean ultimate strength, %	Vickers pyramidal hardness, 2.5-kg. load	Tensile strength divided by specific gravity
3/32-IN. MAHOGANY PLYWOOD, 3-PLY, POLYVINYL BUTYRAL-BONDED, LONGITUDINAL												
78	40	3/32	1,015,000	4600	5300	...	7,870	1	<1	2.8	...	12,300
0	..	3/32	925,000	3000	3600	...	8,680	1	<1	5.8	...	13,600
−38	..	3/32	990,000	4700	5200	...	7,670	1	<1	10.0	...	12,000
1/8-IN. MAHOGANY-POPLAR PLYWOOD, 3-PLY, PHENOLIC-BONDED, LONGITUDINAL												
											Panel	
78	40	1/8	660,000	2800	3700	...	5,520	1	<1	10.4	A	10,200
0	..	1/8	750,000	3200	3700	...	6,380	1	<1	2.9	A	11,800
−38	..	1/8	810,000	3300	3700	...	5,620	1	<1	4.8	A	10,400
78	40	1/8	....	...	...	...	6,370	1	<1	7.8	B	11,800
78	40	3/32	890,000	4200	5200	...	7,560	1	<1	9.7	C	14,000
0	..	3/32	....	...	...	...	8,930	1	<1	1.4	C	16,500
−38	..	3/32	1,300,000	4500	5200	...	8,310	1	<1	1.1	C	15,400
78	40	3/32	....	...	...	...	11,530	1	<1	12.0	D	21,300
78	40	3/32	....	...	...	...	8,580	1	<1	8.0	E	15,900
78	40	3/32	....	...	...	...	8,920	1	<1	3.2	F	16,500
78	40	3/32	....	...	...	...	8,300	1	<1	7.6	G	15,400
78	40	3/32	....	...	...	...	10,030	1	<1	5.0	H	18,500

[a] Designations "A" and "B" in tables refer to different compositions or sources of the same type of plastic material.
[b] Yield strength at 0.1 percent not obtainable. See discussion.
[c] Yield strength at 0.1 percent offset.
[d] A few specimens elongated 30–50 percent. See discussion.





7—Effect of temperature on tensile properties of cellulose acetate butyrate. 8—Effect of temperature on tensile properties of laminated phenolic "A," Grade L

Table III.—Time-Elongation Measurements for Plastics at 78° F.

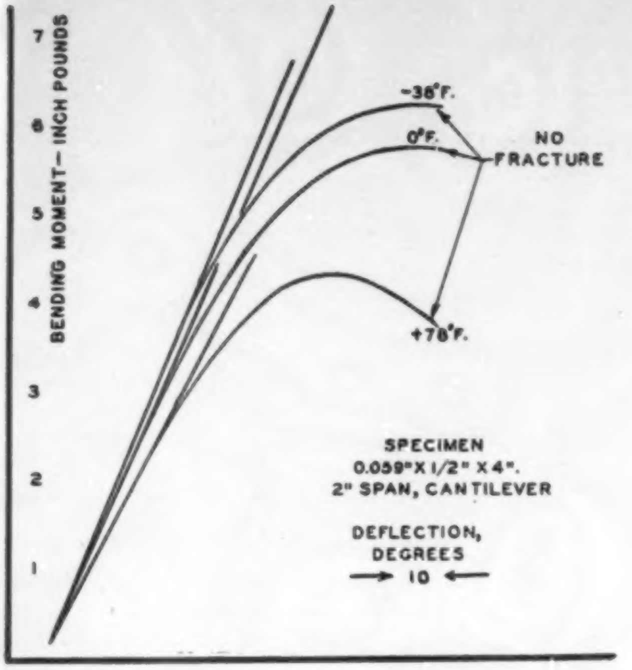
Specimen	Elongation, % in 2 in. — Immediately before fracture	Immediately after fracture	2 hr. after fracture	24 hr. after fracture
METHYL METHACRYLATE				
1	9	3	1	1
2	37	28	26	25
3	10	4	1	1
VINYL CHLORIDE ACETATE COPOLYMER				
1	29	24	24	24
2	90	80	78	78
3	16	14	13	13
CELLULOSE ACETATE				
1	28	20	19	18
2	24	15	13	12
3	22	14	13	12

cold room and 0.10 in. per min. for the laboratory machine.

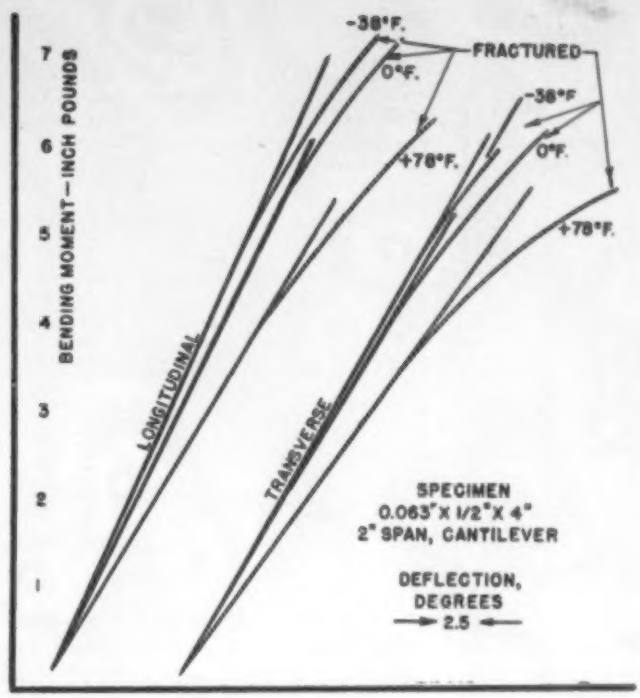
Tensile tests—The average values of the tensile properties are given in Table II. The average percentage deviation from the arithmetic mean is given for the tensile strengths. The deviations for the modulus of elasticity and yield strength were in general less than for the ultimate strength. The proportional limits are approximate and are given as an indication. The average of two tensile tests on methyl methacrylate using Tuckerman strain gages gave the same modulus of elasticity and yield strength as determined with the Olsen gage.

Comparative effects of temperature on the tensile strength and elongation of the materials are shown in Fig. 6. Typical

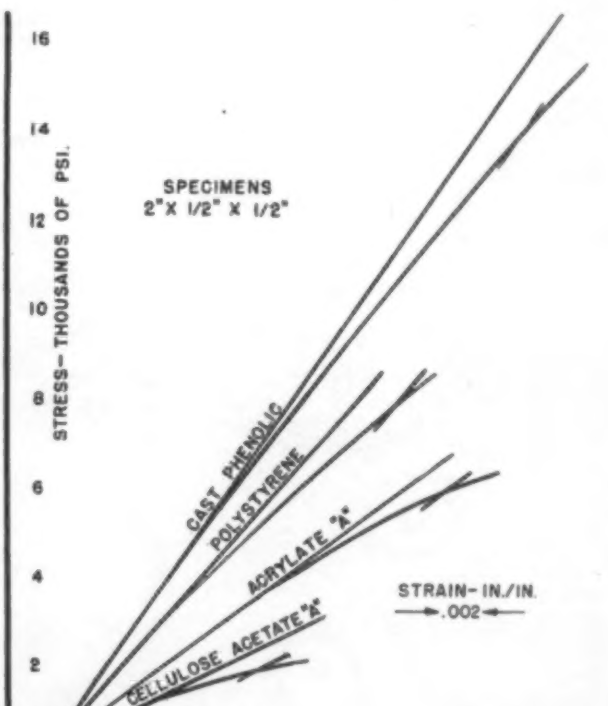
9



10



11



9—Olsen stiffness properties of vinyl chloride-acetate copolymer "A." 10—Olsen stiffness properties of laminated phenolic "B," Grade XX. 11—Compressive properties of plastics at room temperature, 78 F.

tensile stress-strain curves are given in Figs. 7 and 8, and yield strengths at 0.2 percent offset are indicated. No appreciable variation of properties for different thicknesses of sheet was noted except greater elongation for thicker sheet in some cases. However the 0.5-in. cellulose acetate exhibited lower properties probably due to the fact that this was an experimental thickness.

Most of the recovery of elongation of plastics after fracture occurs immediately. In this investigation the elongation was measured immediately before fracture and approximately 2 hr. after fracture. A comparison of elongation measurements made before, immediately after, and two at 24 hr. after fracture at room temperature shows in Table III.

Scratches from strain-gage knife edges or other sources must be avoided on all plastic materials, and particularly on thin specimens. In several tension tests, reduction of ultimate strength and elongation below normal was observed, due to effect of scratches on the surface or slight irregularities along the edges of specimens. These were not averaged with the rest of the determinations.

Stiffness tests—Typical curves obtained on the Olsen stiffness tester are shown in Figs. 9 and 10. These curves are given in terms of in.-lb. and angle of deflection as read on the stiffness tester, and correspond to load-deformation data. At present sufficient study of this machine has not been made to show that these data can be rigorously converted to stress-strain. However, calculations based on simple cantilever beam bending equations were made for modulus of rupture and modulus of elasticity. In all cases, the maximum bending moment was used to calculate the modulus of rupture. In those instances where the material bent 90° without failure, a maximum bending moment appeared to have been reached. It will be noted that the flexural moduli of elasticity in general are somewhat lower than those obtained in tension and bending, and that the ratio of tension to stiffness varies with the material (Tables II and IV). The differences may be due partly to the fact that the specimen used had high width-depth and span-depth ratios, thus introducing plate effects. Also the test itself does not have the sensitivity of the tensile test. However, for the thermoplastic plastics the flexural moduli of elasticity are close approximations of those in tension, and the moduli of rupture are comparable to those obtained in simple beam bending on large specimens. The flexural moduli of elasticity for the thermosetting materials are much lower than the tension moduli, but the moduli of rupture approximate those obtained in bending. The reproducibility of the stiffness tests was good; the deviation of results was not greater than for tensile tests. It is believed

Table IV.—Stiffness Data for Plastics
Olsen stiffness tester, 2-in. span

Temperature, ° F.	*Relative humidity, %*	*Modulus of elasticity, p.s.i.*	*Modulus of rupture, p.s.i.*	*Deflection degrees*	*Average thickness, in.*	*Remarks*
			VINYL CHLORIDE ACETATE COPOLYMER "A"			
78	35	424,000	14,700	90	0.059	No fracture
0	..	496,000	19,500	90	0.059	No fracture
−38	..	512,000	20,700	90	0.059	No fracture
			VINYL CHLORIDE ACETATE COPOLYMER "B"			
78	45	451,000	12,750	90	0.041	No fracture
0	..	523,000	15,580	90	0.041	No fracture
−38	..	546,000	15,800	90	0.041	No fracture
			POLYVINYL ACETAL			
78	35	312,000	4,760	90	0.020	No fracture
0	..	390,000	6,050	90	0.020	No fracture
−38	..	438,000	6,900	90	0.020	No fracture
			CELLULOSE ACETATE "A"			
78	35	236,000	7,900	90	0.062	No fracture
0	..	414,000	16,100	90	0.062	No fracture
−38	..	664,000	26,200	90	0.062	No fracture
			CELLULOSE ACETATE "B"			
78	40	274,000	5,950	90	0.030	No fracture
0	..	520,000	11,300	90	0.030	No fracture
−38	..	705,000	15,700	90	0.030	No fracture
			CELLULOSE ACETATE BUTYRATE			
78	45	135,000	4,330	90	0.055	No fracture
0	..	222,000	7,900	90	0.055	No fracture
−38	..	380,000	12,900	90	0.055	No fracture
			METHYL METHACRYLATE "A"			
78	50	375,000	14,500	90	0.067	No fracture
0	..	510,000	19,300	52	0.067	Fracture
−38	..	590,000	20,000	46	0.067	Fracture
			METHYL METHACRYLATE "B"			
78	35	344,000	14,200	90	0.084	No fracture
0	..	480,000	18,400	40	0.084	Fracture
			LAMINATED PHENOLIC "A," GRADE L, LONGITUDINAL			
78	50	1,038,000	25,600	65	0.064	Fracture
0	..	1,170,000	28,100	52	0.064	Fracture
−38	..	1,280,000	29,100	46	0.064	Fracture
			LAMINATED PHENOLIC "A," GRADE L, TRANSVERSE			
78	50	740,000	18,800	82	0.064	Fracture
0	..	912,000	22,300	67	0.064	Fracture
−38	..	970,000	22,700	54	0.064	Fracture
			LAMINATED PHENOLIC "B," GRADE L, LONGITUDINAL			
78	35	950,000	23,400	53	0.061	Fracture
0	..	1,260,000	26,700	43	0.061	Fracture
−38	..	1,300,000	27,800	41	0.061	Fracture
			LAMINATED PHENOLIC "B," GRADE L, TRANSVERSE			
78	35	780,000	17,900	57	0.061	Fracture
0	..	890,000	18,300	41	0.061	Fracture
−38	..	956,000	19,800	44	0.061	Fracture
			LAMINATED PHENOLIC "B," GRADE C, LONGITUDINAL			
78	35	1,010,000	22,200	52	0.064	Fracture
0	..	1,200,000	24,900	43	0.064	Fracture
−38	..	1,240,000	25,800	40	0.064	Fracture

TABLE IV.—STIFFNESS DATA FOR PLASTICS—*Continued*
Olsen stiffness tester, 2-in. span

Temperature, ° F.	*Relative humidity, %*	*Modulus of elasticity, p.s.i.*	*Modulus of rupture, p.s.i.*	*Deflection degrees*	*Average thickness, in.*	*Remarks*
LAMINATED PHENOLIC "B," GRADE C, TRANSVERSE						
78	35	800,000	17,700	74	0.064	Fracture
0	..	940,000	20,000	58	0.064	Fracture
−38	..	983,000	20,300	49	0.064	Fracture
LAMINATED PHENOLIC "B," GRADE XX, LONGITUDINAL						
78	35	1,200,000	18,600	22	0.063	Fracture
0	..	1,480,000	21,400	20	0.063	Fracture
−38	..	1,660,000	21,800	18	0.063	Fracture
LAMINATED PHENOLIC "B," GRADE XX, TRANSVERSE						
78	35	960,000	16,100	25	0.063	Fracture
0	..	1,240,000	18,900	22	0.063	Fracture
−38	..	1,270,000	17,900	18	0.063	Fracture

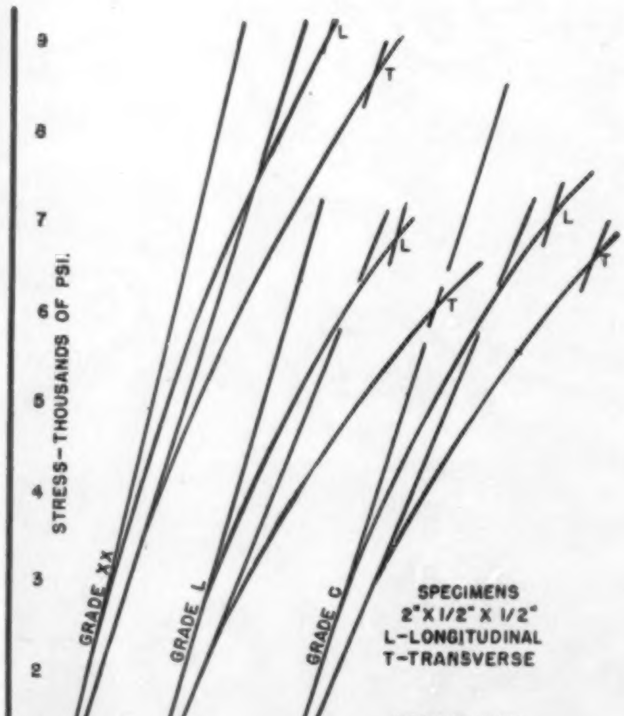
that the curves and the data from the stiffness tests show the same trends as the tensile data and that the stiffness tester offers a rapid and convenient method for making comparative tests at different temperatures for the same material, or for different materials, provided that very nearly the same span-thickness and width-thickness ratios are employed. Data on the Olsen stiffness tester have been reported for comparative tests on cellulose acetate (reference 4).

Bend or beam tests—Modulus of rupture, modulus of elasticity and maximum fiber stress at the elastic limit were calculated from the bending data obtained, using simple beam bending equations. The modulus of rupture was calculated from the maximum load. In those cases where no fracture occurred, a maximum load was reached, and bending deformation was carried to about 2 inches. The fiber stresses at the elastic limit were higher than the tensile proportional limits. The moduli of elasticity are comparable to those obtained in tension (Tables II and V).

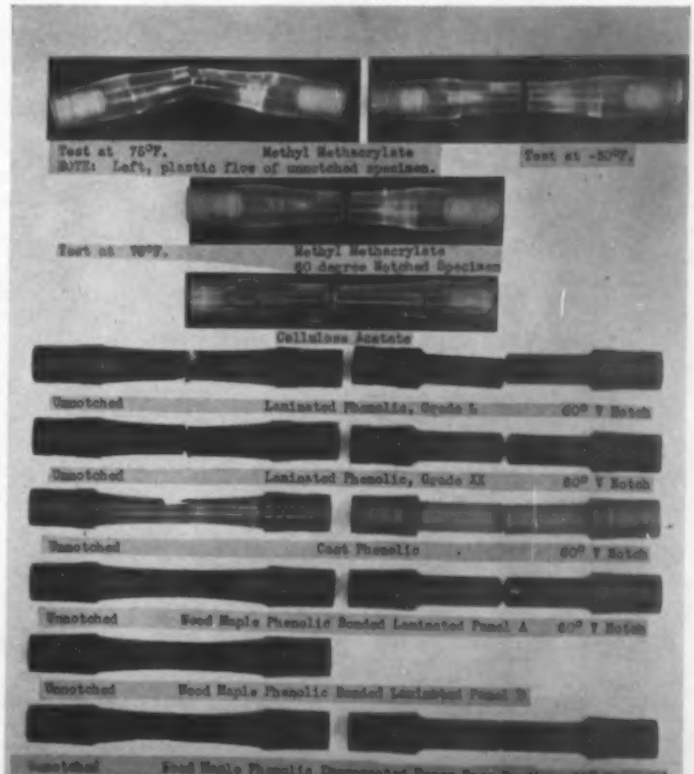
The equations used in bending and stiffness calculations in this report are as follows:

12—*Compressive properties of laminated phenolics at room temperature, 78° F.* **13**—*Fractured wood and plastics fatigue specimens*

12



13



Simple beam, concentrated load at center.

$$s = \frac{Mc}{I} = \frac{PLc}{4I}$$

$$E = \frac{PL^3}{48Iy}$$

Cantilever beam, concentrated load at free end. The Olsen stiffness test approximates this condition at small deflections.

$$s = \frac{Mc}{I}$$

$$E = \frac{PL^3}{3Iy} = \frac{ML^2}{3I(2 \text{ sine } a)}$$

$$E = \frac{4M}{(3I)(0.035a)} = 38.1\frac{M}{Ia} \text{ (for a 2-in. span)}$$

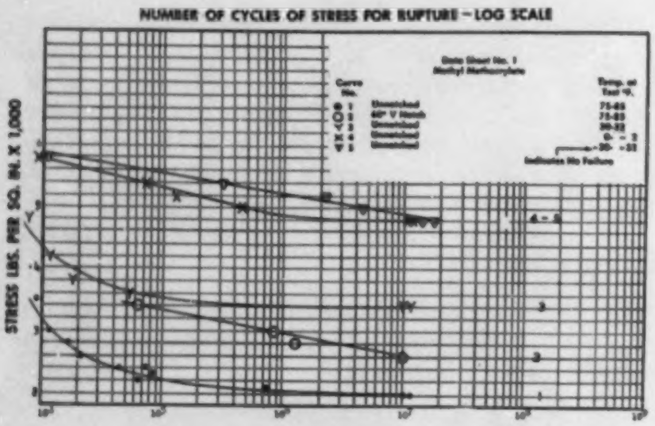
where

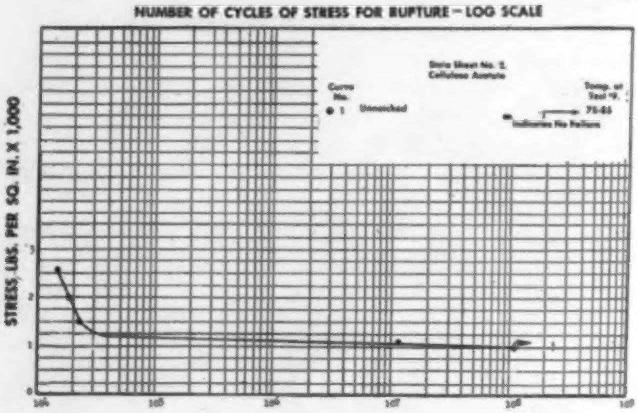
s = extreme fiber stress, p.s.i.
E = modulus of elasticity in flexure
M = bending moment, in.-lb.
c = distance from neutral axis to extreme fiber, in.
I = moment of inertia, in.^{4}
P = load, lb.
L = span length, in.
y = deflection, in.
a = deflection angle, degrees

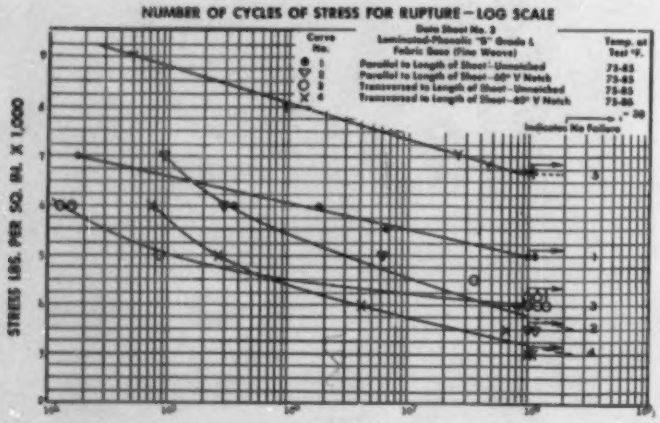
Compressive tests—The compressive moduli of elasticity for the thermoplastic plastics tested were comparable to those obtained in tension and bending, but higher yield strengths were obtained (Table VI). Higher compressive moduli were obtained for the thermosetting plastics than in tension or bending. The compressive strengths of the laminated phe-

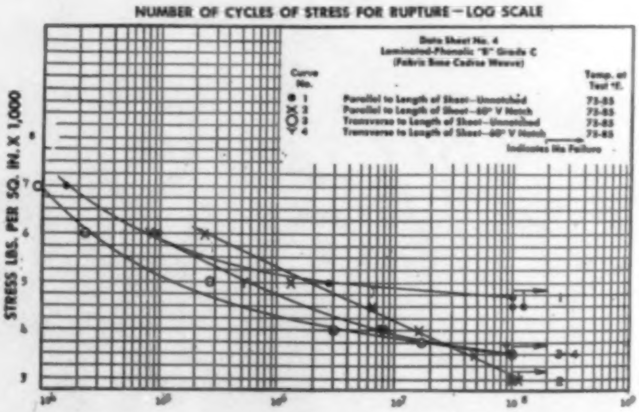
14—***Stress-cycle diagrams in reversed bending, rotating beam***

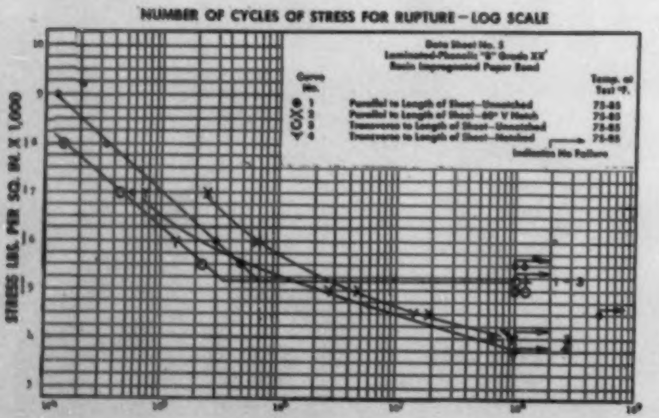
14











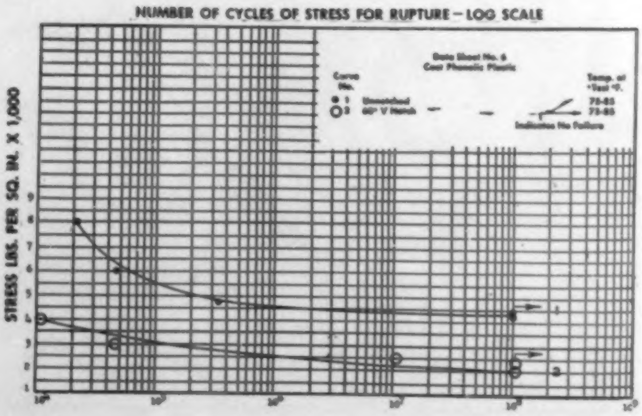


Table V.—Beam or Bending Properties of Plastics

Temperature, °F.	Relative humidity, %	Nominal thickness, in.	Modulus of elasticity, p.s.i.	Fiber stress at elastic limit, p.s.i.	Modulus of rupture, p.s.i.	Remarks
METHYL METHACRYLATE "A"						
78	45	1/2	373,000	5,400	11,370	No fracture
0	..	1/2	490,000	8,000	17,800	Fracture
−38	..	1/2	570,000	9,200	18,300	Fracture
METHYL METHACRYLATE "B"						
78	35	1/8	342,000	5,900	10,740	No fracture
CELLULOSE ACETATE "A"						
78	35	1/2	179,000	2,700	4,900	No fracture
−38	..	1/2	470,000	5,300	18,300	Fracture
VINYL CHLORIDE ACETATE COPOLYMER "A"						
78	35	1/8	....	...	15,500	No fracture
−38	..	1/8	....	...	18,000	No fracture
CAST PHENOLIC						
78	40	1/2	607,000	9,050	12,050	Fracture
78	40	5/16	564,000	15,600	15,600	Fracture
0	..	5/16	650,000	16,500	16,500	Fracture
−38	..	5/16	850,000	13,000	13,000	Fracture
LAMINATED PHENOLIC "B," GRADE L, LONGITUDINAL						
78	40	1/2	1,360,000	3,900	21,400	Fracture
−38	..	1/2	1,480,000	8,000	24,800	Fracture
LAMINATED PHENOLIC "B," GRADE L, TRANSVERSE						
78	40	1/2	1,060,000	3,800	18,200	Fracture
−38	..	1/2	1,210,000	6,500	20,900	Fracture
LAMINATED PHENOLIC "B," GRADE C, LONGITUDINAL						
78	40	1/2	1,350,000	4,000	21,400	Fracture
−38	..	1/2	1,570,000	5,800	24,800	Fracture
LAMINATED PHENOLIC "B," GRADE C, TRANSVERSE						
78	40	1/2	1,050,000	4,000	16,300	Fracture
−38	..	1/2	1,250,000	5,800	19,000	Fracture
LAMINATED PHENOLIC "B," GRADE XX, LONGITUDINAL						
78	40	1/2	1,550,000	7,800	18,400	Fracture
−38	..	1/2	1,870,000	10,200	17,900	Fracture
LAMINATED PHENOLIC "B," GRADE XX, TRANSVERSE						
78	40	1/2	1,280,000	6,300	16,100	Fracture
−38	..	1/2	1,560,000	10,200	14,100	Fracture
1/8-IN. MAHOGANY-POPLAR PLYWOOD, 3-PLY PHENOLIC-BONDED, LONGITUDINAL						
78	40	1/8	....	...	12,700	1/16" poplar core
−38	..	1/8	....	...	12,200	
PHENOLIC-RESIN-IMPREGNATED, COMPRESSED, LAMINATED MAPLE, PANEL A						
78	50	0.59	3,100,000	18,900	36,900	Low resin
0	..	0.59	3,060,000	33,700	39,900	
−38	..	0.59	3,550,000	33,300	45,500	
PHENOLIC-RESIN-IMPREGNATED, COMPRESSED, LAMINATED MAPLE, PANEL D						
78	50	0.63	2,840,000	19,800	32,800	High resin
0	..	0.63	2,960,000	36,100	49,100	
−38	..	0.63	3,260,000	31,400	47,800	

(*Please turn to next page*)

TABLE V.—BEAM OR BENDING PROPERTIES OF PLASTICS—*Continued*

Temperature, ° F.	*Relative humidity, %*	*Nominal thickness, in.*	*Modulus of elasticity, p.s.i.*	*Fiber stress at elastic limit, p.s.i.*	*Modulus of rupture, p.s.i.*	*Remarks*
PHENOLIC-RESIN-BONDED COMPRESSED, LAMINATED MAPLE, PANEL E						
78	50	0.54	3,390,000	19,000	41,200	Resin-paper bond only
0	..	0.54	3,400,000	26,000	48,800	
−38	..	0.54	3,990,000	26,400	51,400	
PANEL G, NON-COMPRESSED						
78	50	1.11	1,530,000	9,300	19,300	Resin-paper bond only
0	..	1.11	1,730,000	13,800	23,900	
−38	..	1.11	1,760,000	15,700	19,400	
PHENOLIC-RESIN-IMPREGNATED, COMPRESSED, LAMINATED BIRCH						
78	..	0.65	4,400,000	20,800	48,200	....
NATURAL BIRCH						
78	..	...	2,100,000	14,100	26,000	....

TABLE VI.—COMPRESSIVE PROPERTIES OF PLASTICS AT 78° F.
1/2 × 1/2 × 2-in. specimens

Type	*Relative humidity*	*Modulus of elasticity*	*Proportional limit tangent*	*Proportional limit, 0.01% offset*	*Yield strength, 0.2% offset*	*Ultimate strength*
	%	*p.s.i.*	*p.s.i.*	*p.s.i.*	*p.s.i.*	*p.s.i.*
Cellulose acetate "A"	35	244,000	900	1050	1,940	[a]
Methyl methacrylate "A"	45	370,000	3000	3400	6,000	12,100
Methyl methacrylate "B"	45	354,000	3000	3400	5,900	11,900
Polystyrene "B"	35	560,000	2200	2600	8,050	15,200
Cast phenolic	35	710,000	3400	4100	13,800	23,600
Laminated phenolic "B," grade L						
Longitudinal	35	1,720,000	2300	3100	6,840	25,770
Transverse	35	1,320,000	1700	2500	6,080	24,690
Laminated phenolic "B," grade C						
Longitudinal	35	1,600,000	2500	3200	7,100	27,800
Transverse	35	1,200,000	2500	3200	6,620	27,540
Laminated phenolic "B," grade XX						
Longitudinal	35	2,150,000	1800	2800	9,070	23,780
Transverse	35	1,620,000	3200	3900	8,650	23,420

[a] Load drops off after a stress of 3800 p.s.i. is reached, then recovers and increases indefinitely as cross-sectional area increases.

nolic materials were practically the same both longitudinally and transversely and were also almost equal for three types of fillers. The compressive proportional limits and yield strengths obtained for these materials were less than those in tension. Also the difference between the yield strengths longitudinally and transversely in compression was small compared to the difference found in tension. Stress-strain curves are shown in Figs. 11 and 12.

Fatigue tests—The thermoplastics and the thermosetting phenolic materials reinforced with fabric and paper have similar characteristics when subjected to alternating bending stresses, in that the materials developed excessive heat which may account partly for the low fatigue strength. Specimens cut from thermoplastic materials developed sufficient heat to cause a plastic flow in the center of the specimen at failure, Fig. 13. This condition of heating occurred at normal and subnormal temperatures. The results of the fatigue tests are presented in Table VII and Figs. 14 to 16.

The fatigue limit for methyl methacrylate is increased 70 percent at a temperature of 32° F. and 125 percent at 0° F. Between temperatures of 0° F. and −30° F. the fatigue limit remained constant. A 60° circular notch cut in the center of the specimen increased the fatigue limit 30 percent at normal temperature.

Some difficulty was encountered in testing specimens of cellulose acetate due to excessive distortion in the material caused by the heat which developed during repeated stress action. The fatigue limit was 1000 p.s.i. compared to 2000 for methyl methacrylate. The Krouse plate or sheet fatigue machine, which has a constant deflection, may be more suitable for testing this particular type of material.

Specimens cut from laminated phenolic materials, of either fabric or paper base, developed higher fatigue strength longitudinally than for those cut transversely. However, specimens cut parallel to the length of the sheet showed greater

(*Please turn to page 122*)

TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

THE TEGOWIRO PROCESS. British Plastics *14*, 538, 540 (Feb. 1943). Results of recent investigations of the hot wire method of gluing wood in Germany are reported. By passing an electric current through the net the temperature in the glue layer required to cure the resin is attained in a few minutes. Wire of 0.3 mm. diameter is used. Usable joints were obtained for rough wood containing up to 30 percent moisture. Recommendations are given regarding clamping pressures, temperatures and curing times to be employed in this process.

PROBLEMS IN THE USE OF PLYWOOD IN AIRCRAFT CONSTRUCTION. A. Klemin. Mech. Eng. *65*, 105–9 (Feb. 1943). The immediate objectives of the A.S.M.E. Research Committee on Plywood in Aircraft Construction are discussed. The problems being considered have been divided into the following tentative classes: 1) aircraft veneer and plywood manufacture; 2) selection, inspection availability of materials and specifications; 3) adhesives and their application; 4) special fabrication processes; 5) plywood components of the airplane, fittings and connections; 6) airplane construction and assembly in relation to plywood; 7) testing of plywood and plywood parts; 8) strength properties of plywood; 9) structural analysis; 10) bibliography.

PLYWOOD ADHESIVES. Aviation *42*, 173–5 (Jan. 1943). The characteristics and handling methods of 10 types of plywood adhesives are given in tabular form.

RELATIVE MERITS OF MATERIALS USED FOR LIGHT WEIGHT STRUCTURES. F. Platt. Product Eng. *14*, 67–72 (Feb. 1943). Aluminum, stainless steel and resin-bonded plywood are compared for aircraft structures. No one material can be considered superior to all others for lightweight construction. The factors governing design calculations for strength and rigidity are discussed.

Chemistry

MELAMINE - FORMALDEHYDE CONDENSATION PRODUCTS. A. Gams, G. Widmer and W. Fisch. British Plastics *14*, 508–20 (Feb. 1943). Experimental work on the preparation of melamine condensation products is described in detail. Analyses of the unhardened and hardened resins for carbon, hydrogen, oxygen and nitrogen are reported. In these experiments the number of mols of formaldehyde per mol of melamine was varied from 2 to 6. Products produced by the etherification of methylol-melamine and slightly hardened resins are described.

EFFECT OF HIGH TEMPERATURES ON CELLULOSE TRIACETATE. W. Schröder. Kunststoffe *32*, 82 (1942). The effect of high temperatures on cellulose triacetate was studied by noting the changes in mechanical, electrical and chemical properties. Exposure to 120° C. for 30 days did not result in any deterioration of the insulating properties; the mechanical strength decreased. The chemical stability was determined by measuring the viscosity and pH; high temperatures caused a decrease in both. Cellulose triacetate is a suitable dielectric material for use at 80° C.

Properties

STRENGTH AND PROPERTIES OF PLEXIGLAS. W. F. Bartoe. Aviation *42*, 128–31, 135 (Jan. 1943). The fundamental strength factors and impact strength tests of methyl methacrylate polymer are discussed. Data are given which show the effects of temperature, shape of notch, surface irregularities, thickness, shape, rate of straining and area on the impact strength of the plastic. The impact strength determined by the Charpy method, notched and unnotched, is the same for all temperatures between −70° C. and 70° C. A slight variation is shown by the falling ball test, the thicker specimens showing a slight increase at low temperatures, the thinner specimens showing variation at several points over the temperature range. The impact strength increases with thickness and area and curved sections are stronger than flat pieces.

MECHANISM OF CREEP-PATH FORMATION. Plastics 7, 9–14 (Jan. 1943). The results of laboratory work in Germany on the causes and elimination of electrical leakage at the surface of organic insulating materials are reported. Materials for which the ash volume is small or in which the ash occurs in isolated masses are practically safe against the formation of creep paths. For other materials, danger of the occurrence of creep paths can be reduced by the use of satisfactory designs of insulating surface.

RELATIONSHIP BETWEEN STRUCTURE AND STRENGTH CHARACTERISTICS OF COMPRESSED PHENOLIC PLASTICS. W. Siegfried. Schweiz. Arch. angew. Wiss. Techn. *8*, 255–62 (Aug. 1942). In a metal, applied stress causes a large deformation before fracture occurs, while volumetric stressing causes only small deformation; a phenolic plastic without filler gives only small deformation in both cases. In the metal the volumetric strength is greater than the structural strength; the reverse is the case with the unfilled phenolic plastic. The type of filler employed has a considerable effect on the tensile strength, e.g., sawdust gives a fracture surface perpendicular to the direction of the applied stress, asbestos causes it to slope, while textile fibers produce the most inclined form.

CREEP AND CREEP RECOVERY IN PLASTICIZED POLYVINYL CHLORIDE. Herbert Leaderman. Ind. Eng. Chem. *35*, 374–8 (Mar. 1943). The time effects on the mechanical behavior of plastics can be explained by the existence of a delayed elasticity superimposed upon Hooke's law or instantaneous elasticity, the delayed component being a function of the previous loading history. It is shown that plasticized polyvinyl chloride obeys this principle under small longitudinal deformations. Such behavior is not unexpected at elevated temperatures in resins in which chemical cross bonds link the primary valence chains. It must be assumed that in the plasticized polyvinyl chloride, points of entanglement exist between the chains which are sufficiently strong to prevent any observable slippage under the conditions of test. The creep and creep recovery must be due to the straightening and refolding of the chains between the points of entanglement. Such straightening and folding of the primary valence chains is presumably retarded by the existence of secondary forces between the chains. These secondary forces are diminished when temperature is raised or plasticizer is added.

Testing

COMMON LANGUAGE OF NEW STANDARD SIMPLIFIES COLOR SPECIFICATION. Product Eng. *14*, 91–4 (Feb. 1943). The color notation system of the Munsell "Book of Color" is described. The relation of this system to spectrophotometric measurements, the basic method for determining color, is shown and explained. The advantage of the Munsell system in specification writing is pointed out.

POLYVINYLIDENE CHLORIDE AS A MOISTUREPROOF FILM MATERIAL. E. E. Halls. Plastics 7, 74–80 (Feb. 1943). Moisture permeability and aging tests on polyvinylidene chloride film were conducted in comparison with films of rubber hydrochloride, regenerated cellulose, cellulose acetate, polyethylene, waxed parchment and hydrated paper. It is superior to all of these in moisture impermeability and is stable under wet conditions. It shrinks appreciably under hot, dry conditions and, to a lesser degree, in hot, moist atmospheres. Polyethylene is adjudged to be the most stable under the variety of conditions investigated and its permeability to moisture is very low.

PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to publishers

General

CHEMURGY AND THE WAR. R. S. Aries. Chemical Industries *52*, 188–92, 250 (Feb. 1943). The production of alcohol from farm products and of plastics from agricultural waste materials is discussed. The costs of raw materials for the production of molding powders from agricultural materials are estimated at $0.045 per lb. and $0.062 per lb. for thermoplastic and thermosetting corncob plastics respectively; at $0.025 to $0.054 per lb. for bagasse plastics; at $0.0601 per lb. for cottonseed meal plastics; and at $0.0756 per lb. for soybean plastic. The estimated cost of the raw materials for standard phenolic molding powder is $0.0756 per lb. Values for the physical properties of three types of bagasse plastics and of cottonseed meal plastics are given.

HIGH PRESSURE MOLDINGS OR IMPREGNATED PLYWOOD FOR THE CAR BODY? D. Warburton Brown. Plastics 7, 3–8, 46 (Jan. 1943). Under existing conditions, molded plastic materials could not hope to compete with the normal pressed-steel body. It would appear to be less of a problem to make an economic proposition of the use of molded plywood for this application.

NEW MATERIALS AND FINISHES OF 1942. F. P. Peters. Metals and Alloys *17*, 109–12 (Jan. 1943). The nonmetallic materials for design and construction and finishes and coatings introduced during 1942 are listed in a table with trade name, nature, outstanding characteristics, applications and manufacturer.

Materials

STARCH STUDIES. POSSIBLE INDUSTRIAL UTILIZATION OF STARCH ESTERS. J. W. Mullen II and Eugene Pacsu. Ind. Eng. Chem. *35*, 381–4 (Mar. 1943). The properties of starch triesters which might make them industrially useful are discussed. Because of the molecular shape of starch, its esters will probably never produce molded articles of great strength. In molding, their use will be confined to that of a diluent and plasticizer for other thermoplastic materials. Definite possibilities do exist for these esters in the coating, sizing and adhesive industries. The starch esters may find their greatest usefulness in the preparation of aqueous emulsions or suspensions of high polymers and the compounding of soft rubberlike plastics.

COLORING MATERIALS FOR COPOLYMER VINYL CHLORIDE-ACETATE COMPOUNDS. F. G. Clark. Ind. Eng. Chem. *35*, 368–74 (Mar. 1943). Properties of vinyl chloride acetate copolymer resins are discussed relative to their effect on the choice of coloring materials. Tests for bleeding characteristics, light stability and heat stability of colors in these resins are outlined. Tabular results are given for 25 red, 7 orange, 16 yellow, 6 green, 9 blue, 4 white and 3 black commercial coloring materials. Results are also given for 51 generalized chemical types. Wide discrepancies have been found between properties of coloring materials in this copolymer resin and those in inks and surface coatings.

Molding and fabricating

ALTERNATIVE METHODS AND MATERIALS FOR TOOL CONSTRUCTION. J. Hofton. British Plastics *14*, 473–4, 476–7 (Jan. 1943). Developments in beryllium copper, high-duty cast iron, zinc alloys, chinese bronze and aluminum alloys to provide more economical and speedier production of molds are reviewed. Large moldings of laminated fabric, wood and paper will be produced at lower ranges of pressure with either a male or female die and a rubber bag to consolidate the material. Some of these alternate tool alloys may be sufficiently accurate and strong for use in this type of molding.

Applications

ORGANIC PLASTICS AS INSULATING MATERIALS. John Delmonte. Elec. Eng. *62*, 19–23 (Jan. 1943). The electrical properties of most of the commercial plastics are discussed and data on dielectric strength, power factor, loss factor, dielectric constant and insulation resistance are given. The uses of plastics which depend on their electrical properties are pointed out.

PLASTICS IN ASSEMBLED BUILDING STRUCTURES. G. Féjer. Plastics 7, 16–24, 64–70 (Jan. and Feb. 1943). Suggestions are given for the prefabrication of insulating walls and sub-structural framing members. An interesting chart shows the correlation between the materials of the plastics industry and those needed for prefabrication of buildings.

"HYDULIGNUM" LAMINATED-WOOD AIRSCREWS. Engineering *155*, 27–8 (Jan. 8, 1943). The manufacture and properties of "Hydulignum" laminated wood for airplane propeller blades are described. The results of tests on an airplane propeller made of this material are given.

BUILDERS' FURNITURE—ITS DESIGN AND PRODUCTION. Plastics 7, 25–30 (Jan. 1943). H. Turnwald, a leading German designer in plastics, describes new forms of door handles, door knobs, door shields and clothes hooks which take full advantage of the properties of plastics and suggest possibilities for more economic molding.

Coatings

PROTECTING WOOD WITH SYNTHETIC SURFACE COATINGS. O. Jordan. Fette u. Seifen *48*, 433–4 (1941). Lacquers made with high molecular weight materials have no special tenacity for wood, because the cohesion is unusually strong while adhesion is weak. Tenacity is good when the adhesion exceeds the cohesion. The best tenacity is obtained by using materials of low molecular weight without pigments. Good wood surfacing properties are obtained with 1) oil modified aldehydic resins, 2) cellulose nitrate mixed with alkyd resins containing monocarboxylic acids, 3) cellulose nitrates mixed with elastic urea resins and 4) superpolyamides.

BONDERIZED AND LACQUERED SHEET STEEL. Iron Age *151*, 39, 86–8 (Jan. 14, 1943). The results of recent investigations on substitutes for tinplate in the fabrication of food cans in Germany indicate that a thin bonderized coating does not have much effect on lacquer deformability, slightly reduces impact resistance and improves considerably the boiling resistance and the subsurface corrosion resistance.

THE STABILITY OF RESINS AND VARNISHES AGAINST GASEOUS CHEMICAL SUBSTANCES. M. F. Ryskalova. Izolyatsionnye Materialy, Org. Dielektriki, Trudy Vsesoyuz. Elektrotekh. Inst. *1940*, No. 38, 82–9. The action of hydrogen sulfide, carbon dioxide, sulfur dioxide, sulfur trioxide, nitrogen dioxide and acetic acid gas on varnish films made from various synthetic and natural resins, bitumens and cellulose derivatives was investigated. The phenolic resin film was the only film not completely destroyed by sulfur trioxide and it became very brittle. Acetic acid vapors penetrated all the films, except shellac, on copper. Alkyd resins, phenolic resins, asphalts and some combinations containing these withstood the action of hydrogen sulfide the best. In nitrogen dioxide the best results were obtained with the alkyd resins and compositions containing alkyd resins. Methyl methacrylate resin, alkyd-asphalt combinations, phenolic resins, polyvinyl chloride, ester gum mixed with benzylcellulose and some combinations of alkyd resins and phenolic resins were resistant to sulfur dioxide.

Ewing Galloway

U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

DENTURES. Leif Underdahl. U. S. 2,310,132, Feb. 2. Interpolymers of vinyl chloride, acrylic acid and methyl methacrylate for use in dentures.

CLOTHESPIN. Wm. W. van der Clute. U. S. 2,310,156, Feb. 2. A plastic clothespin with a U-shaped lip member lining its prongs.

BRUSHES. Maurice Abrams (one-half to Vera Schectman-Abrams). U. S. 2,310,186, Feb. 2. Making brushes by superposing bristles on a strip of material impregnated with a thermosetting phenolic resin, laminating the resulting mat and setting the resin.

PHOTOGRAPHIC RESIN. G. T. Eaton and J. I. Crabtree (to Eastman Kodak Co.). U. S. 2,310,223, Feb. 9. A photographic resin containing vinyl alcohol groups is hardened with a zirconium salt solution.

PROPELLER LACQUER. G. S. Adlington (to Rayoid Mfg. Co., Ltd.). U. S. 2,310,272, Feb. 9. Cellulose ester finishes for aircraft propellers are plasticized by a bath of ethyleneglycol phthalate dissolved in ethylene dichloride, dichloroethyl ether or methyl chloride.

GUMMED PAPER. F. W. Humphner (to Mid-States Gummed Paper Co.). U. S. 2,310,292, Feb. 9. Protecting adhesive films on paper from high humidity, but not from liquid water, by a thin film of polyvinyl alcohol.

ESTER GUM. A. L. Rummelsburg (to Hercules Powder Co.). U. S. 2,310,374–5, Feb. 9. Polymerizing rosin or its esters without decomposition by action of phosphorus pentoxide or a polyphosphoric acid; and polymerizing acyclic terpenes with phosphoric acid, then hydrolyzing the phosphate ester in acid solution.

GLASS INSULATION. B. J. Dennison (to Pittsburgh Plate Glass Co.). U. S. 2,310,402, Feb. 9. Glass insulation, made in laminated form from glass plates and resin interlayers, has projecting metal strip inserts serving as vapor seals across the glass plates.

VARIEGATED FINISHES. J. F. Summersgill (to Armstrong Cork Co.). U. S. 2,310,495, Feb. 9. Making a hard surface covering from a variegated product by extrusion in sheet form with directed graining.

OLEFIN RESINS. M. M. Barnett (to Freeport Sulphur Co.). U. S. 2,310,605, Feb. 9. Reacting sulfur dioxide with an olefin or with pentyne-1, hexyne-1, vinyl acetate, allyl alcohol or allyl propionate in presence of an olefin ozonide.

HARD RUBBER PANELS. E. R. Dillehay (to Richardson Co.). U. S. 2,310,619, Feb. 9. In curing hard rubber panels a regenerated cellulose sheet is interposed between the rubber composition and the mold face.

ITACONATE INTERPOLYMERS. G. F. D'Alelio (to General Electric Co.). U. S. 2,310,731, Feb. 9. Interpolymerizing diallyl itaconate with ethyl methacrylate.

LUMINOUS ADHESIVE TAPE. J. B. Leavy (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,310,740, Feb. 9. Luminous adhesive tape has a clear cellulose ether sheet base, a luminescent coating in a cellulose ether vehicle and a pressure-sensitive adhesive on the other side.

PALETTE. Wm. A. and Ilon M. Sillman. U. S. 2,310,752, Feb. 9. Palettes for artists are made of two transparent plastic sheets, joined by an interlayer resembling an artist's canvas.

FAN STAND. Alfred F. Fukal (to Wm. W. Welch). U. S. 2,310,772, Feb. 9. A plastic fan stand has a motor guard in the form of stacked hoops.

VINYL ESTERS. W. E. Hanford and W. E. Mochel (to E. I. du Pont de Nemours and Co., Inc.) U. S. 2,310,780, Feb. 9. Polymerizable vinyl esters of tertiary carboxylic acids with not more than 12 carbon atoms.

UREA RESINS. O. L. Kupfer (to Stein, Hall and Co.). U. S. 2,310,794, Feb. 9. Melting urea to form biuret and heating the melt with a dry powdered formaldehyde compound.

RAINCOATS. L. Becker (to S. Buchsbaum and Co.). U. S. 2,310,889, Feb. 9. Raincoats, gloves and the like are made with the aid of a Vinylite type resin, a thermosetting phenolic resin, a methyl methacrylate polymer and a plasticizer.

VARNISH RESIN. R. P. Carlton and B. J. Oakes (to Minnesota Mining and Mfg. Co.). U. S. 2,310,935, Feb. 16. Reacting an oil-soluble alkyd resin with a drying oil modified phenolic resin.

ACETAL RESINS. G. L. Dorough and D. M. McQueen (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,310,943, Feb. 16. Sulfonated or carboxylated derivatives of polyvinyl acetals containing groups capable of coupling with diazo compounds to form dyes.

ACRYLONITRILE INTERPOLYMERS. E. L. Kropa (to American Cyanamid Co.). U. S. 2,310,961, Feb. 16. Using methylcellulose as emulsifier in aqueous dispersions of resins formed by interpolymerizing acrylonitrile with isopropenyltoluene.

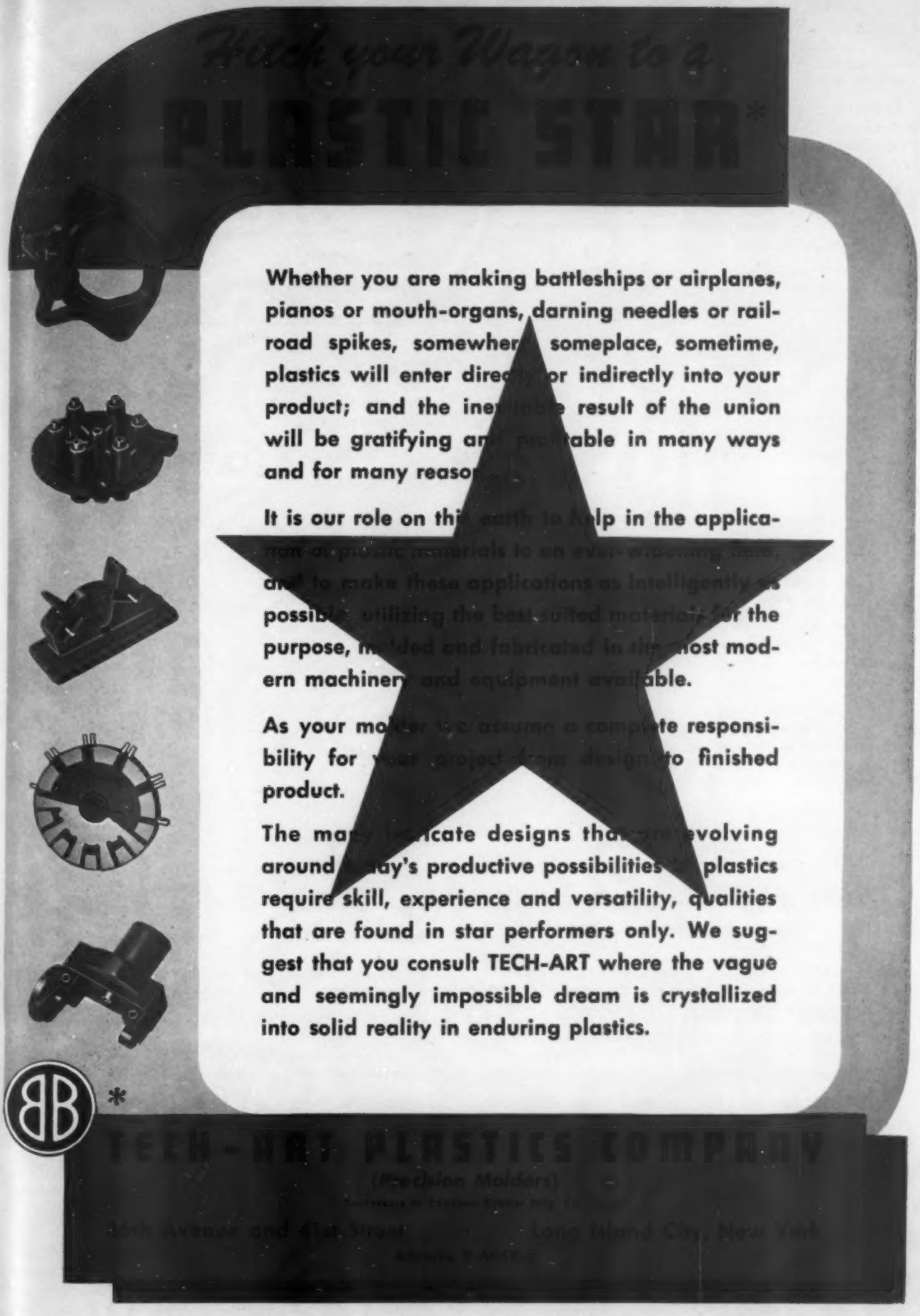
SOUND RECORD. E. E. Sawyer (to Canal National Bank, trustee). U. S. 2,310,998, Feb. 16. Making sound records from an aqueous pulp of an uncured synthetic resin and a fibrous filler, deposited on a perforated die.

TANK LINER. R. M. Thomas and W. J. Sparks (to Jasco, Inc.). U. S. 2,311,004, Feb. 16. Lining tank cars or the like with a chemically curable macromolecular isobutene polymer.

ACETATE ARTICLES. Lloyd V. Casto. U. S. 2,311,156, Feb. 16. Decorating and molding cellulose acetate sheet articles by means of an intaglio transfer using a toluene-sulfonamide-formaldehyde resin ink, a coating over the intaglio design and a molding device for shaping the articles.

MOLDINGS. J. Jaenicke, H. Knoop, H. Miedel and O. Schweitzer (to American Lurgi Corp.). U. S. 2,311,233, Feb. 16. Mixing a small proportion of a hydraulic cement with an aqueous dispersion of a synthetic resin, and molding the product.

(Please turn to next page)


Hitch your Wagon to a
PLASTIC STAR*
Whether you are making battleships or airplanes, pianos or mouth-organs, darning needles or railroad spikes, somewher someplace, sometime, plastics will enter dire or indirectly into your product; and the ine result of the union will be gratifying a table in many ways and for many reaso
It is our role on thi lp in the applica-
possib the purpose, ost mod-
ern machiner ble.
As your mo te responsi-
bility for o finished product.
The ma cate designs tha volving around ay's productive possibilities plastics require skill, experience and versatility, qualities that are found in star performers only. We suggest that you consult TECH-ART where the vague and seemingly impossible dream is crystallized into solid reality in enduring plastics.
BB *
TECH-ART PLASTICS COMPANY
(Precision Molders)
36th Avenue and 41st Street
Long Island City, New York

COATING METALS. G. M. Powell III (to Carbide and Carbon Chemicals Corp.). U. S. 2,311,249, Feb. 16. Thermally stable light-fast coatings with strong adhesion to metal contain a Vinylite type resin and an acrylate or methacrylate polymer.

PLASTICIZER. C. E. Staff and W. N. Stoops (to Carbide and Carbon Chemicals Corp.). U. S. 2,311,259, Feb. 16. Plasticizing vinyl resins with di(2-ethylhexyl) methyl hexahydrophthalate.

PLASTICIZERS. C. E. Staff (to Carbide and Carbon Chemicals Corp.). U. S. 2,311,260–1, Feb. 16. Esters of endomethylene hydrophthalic acids with alkyleneglycol monoethers or with hexyl or higher alcohols.

SULFIDE PLASTICS. C. Snyder (to Liatex Corp.). U. S. 2,311,284, Feb. 16. Reacting olefins with alkaline polysulfides and compounding the products with neoprene, ozokerite, sulfur dichlorohydrin plastic and sulfur.

PIPE LINING. R. M. Thomas and W. J. Sparks (to Jasco, Inc.). U. S. 2,311,308, Feb. 16. Lining pipe with a vulcanizable isobutene: butadiene interpolymer.

STEERING WHEEL. J. B. Tegarty (to Sterling Injection Molding, Inc.). U. S. 2,311,317, Feb. 16. Covering the metal core of a steering wheel with a molded plastic in sections.

DIALLYL ESTER POLYMERS. T. F. Bradley (to American Cyanamid Co.). U. S. 2,311,327, Feb. 16. Polymerizing diallyl fumarate, sebacate, succinate, adipate or phthalate.

AMINE RESINS. W. B. Johnston (to American Cyanamid Co.). U. S. 2,311,341, Feb. 16. Plasticizing amine-aldehyde resins with alcohols formed by hydrogenating polymers of aliphatic polyene acids.

ZEIN FILM. O. C. H. Sturken (to Corn Products Refining Co.). U. S. 2,311,485, Feb. 16. Zein films containing 5–20 parts of sorbital and 20–50 parts of triethanolamine per 100 parts of zein.

TREATED FABRIC. Wm. C. Toland and Ellis Bassist (to Wm. C. Toland). U. S. 2,311,489, Feb. 16. Covering a fibrous web with an aqueous dispersion of a resin, applying an aqueous dispersion of a colloid before the resin glue is fully dry, and drying the resin to a hard water-repellent state.

WALL PANELS. Eugene Caligari, Jr. U. S. 2,311,518, Feb. 16. Applying a smooth adherent plastic surface layer to plywood with the aid of a flexible surfacing sheet which is later stripped off.

STORAGE BATTERIES. E. R. Dillehay (to Richardson Co.). U. S. 2,311,524, Feb. 16. Molding storage battery cases from a thermoplastic composition in a cooled mold, removing the partially set molding and plunging it into cold water.

IRIDESCENT PLASTICS. I. and L. Gertzog (to Rochester Button Co.) U. S. 2,311,533, Feb. 16. Imparting iridescence to thermosetting resin products with lead acid arsenate.

REPLICAS. M. R. Hutchison (to Mock-Up Inc.). U. S. 2,311,547, Feb. 16. Bonding paper to a metal support by a plastic interlayer for manufacture of photosensitized templates.

AMIDE POLYMERS. R. A. Jacobson and C. J. Mighton (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,311,548, Feb. 16. Interpolymerizing N-methylmethacrylamide with methyl methacrylate.

MOLD FORM. J. A. Miller (to Rudolph Wurlitzer Co.). U. S. 2,311,561, Feb. 16. A heated mold form for shaping bonded plywood veneer panels in curved designs.

OLEFIN INTERPOLYMERS. M. Otto, H. Gueterbock and A. Hellemanns (to Jasco, Inc.). U. S. 2,311,567, Feb. 16. Interpolymerizing isobutene with vinyl isobutyl ether on a flat support by contact with boron trifluoride.

PLASTICIZED POLYAMIDE. G. T. Vaala (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,311,587, Feb. 16. Plasticizing synthetic linear polyamides with hydroabietyl alcohol.

STYRENE INTERPOLYMERS. G. H. Coleman and J. W. Zemba (to Dow Chemical Co.). U. S. 2,311,607, Feb. 16. Making white opaque granular interpolymers of styrene and diallyl maleate in presence of an azo dye.

HOT MELT COATING. T. A. Kauppi and M. Kin (to Dow Chemical Co.). U. S. 2,311,609, Feb. 16. A low viscosity color-stable coating for hot melt application contains a cellulose ether, a non-thermosetting resin compatible therewith, a wax, a plasticizing solvent, a mineral wax and hydrogenated rosin.

TRANSPARENT PRODUCT. G. Slayter (to Owens-Corning Fiberglas Corp.). U. S. 2,311,613, Feb. 16. Embedding glass fibers in a transparent organic plastic in which the fibers are ordinarily invisible.

STYRENE INTERPOLYMERS. J. W. Zemba and G. H. Coleman (to Dow Chemical Co.). U. S. 2,311,615, Feb. 16. Interpolymerizing styrene with a lower interpolymer of styrene and diallyl maleate.

POURING SPOUT. Lee C. Lanfare. U. S. 2,311,763, Feb. 23. A plastic unit closure terminating in a pouring spout.

RUBBER DERIVATIVES. T. C. Morris (to Wingfoot Corp.). U. S. 2,311,770, Feb. 23. Converting rubber to a condensation product by the action of a boron fluoride ether or ester complex.

ROSIN DERIVATIVE. P. H. Scrutchfield (to Hercules Powder Co.). U. S. 2,311,781, Feb. 23. Condensing unsaturated rosin acids or their esters with an aldehyde and an acid such as maleic acid.

BRUSHES. C. E. Dawson (to Pro-phy-lac-tic Brush Co.). U. S. 2,311,818, Feb. 23. Acrylate resin brush backs are heated to 140° F. to relieve internal strains set up by mechanical treatments.

MOISTUREPROOF COATING. G. S. Heaven and W. Berry (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,311,831, Feb. 23. A nitrocellulose lacquer for moistureproofing transparent wrapping foil contains an alkyd resin, paraffin wax and dibutyl phthalate.

CERAMIC TRANSFERS. H. F. Scheetz, Jr. (to Fuller Label and Box Co.). U. S. 2,311,876, Feb. 23. A thin self-sustaining organic plastic film, destroyed in firing, is used as vehicle in transfer designs for decorating ceramic ware.

PRINTING PLATE. Wm. C. Toland and Ellis Bassist (to Wm. C. Toland). U. S. 2,311,889, Feb. 23. A lithographic plate has a layer of polyvinyl alcohol between the base and the lithographic surface.

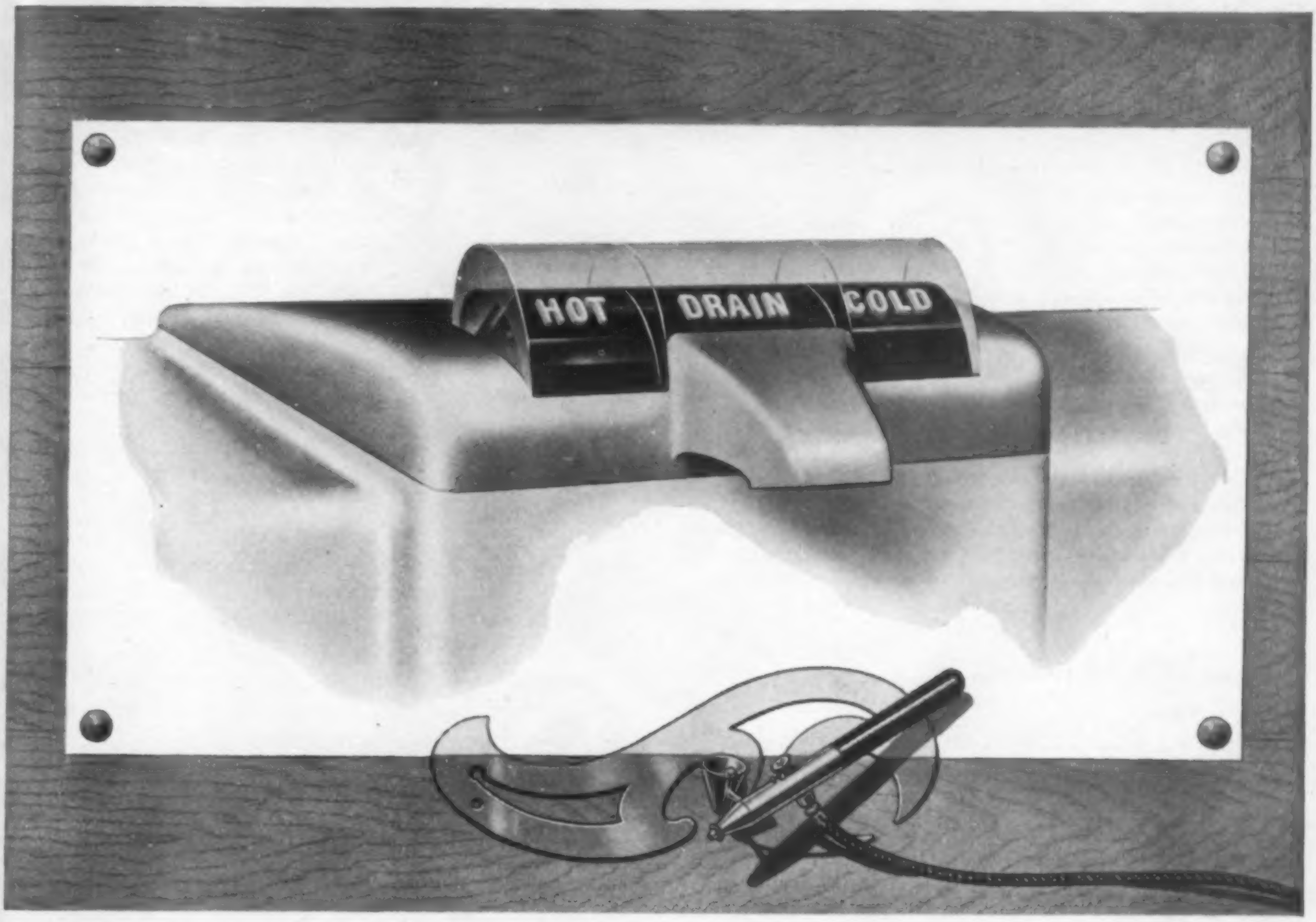
WRAPPING FOILS. W. D. R. Straughn (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,311,910, Feb. 23. Softening cellulosic wrapping foils with urea, ethanolformamide, an alkylolamine derivative and a color inhibitor.

SHELLAC FINISH. R. C. Swain and P. Adams (to American Cyanamid Co.). U. S. 2,311,911, Feb. 23. Blending shellac with an alkylated melamine-formaldehyde in coatings.

SUPPORT. H. F. Hagemeyer (to Castings Patent Corp.). U. S. 2,311,942, Feb. 23. A spring-cushioned ring for supporting plastic articles which are subject to expansion and contraction.

EYEGLASS FRAME. G. E. Nerney (to Bay State Optical Co.). U. S. 2,311,991, Feb. 23. A resilient plastic bridge member for spectacle frames.

Mrs. *Doe through the looking glass*



From the Drawing Boards of Sundberg and Ferar

Through the looking glass of Mrs. Average Citizen — or better still, through the drafting boards of today's important designers—there's a better, brighter world awaiting.

Just one example of what today's designers foresee for post war plastics applications is this sleek, simple, unit construction sink fixture which may one day add convenience to your kitchen or bathroom. This, along with plastics plumbing accessories, spray nozzles, lighting fixtures, towel racks, and many others.

It's increasingly important today to think ahead, and when you're planning for plastic moldings, remember the name Kurz-Kasch. The Kurz-Kasch trade mark has been stamped on many of America's outstanding plastic moldings for more than a generation.

KURZ-KASCH

Planners and Molders for the Age of Plastics

Kurz-Kasch, Inc., 1417 South Broadway, Dayton, Ohio.
Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas • St. Louis • Toronto, Canada. *Export Offices:* 89 Broad St., New York City.

PUBLICATIONS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

Plastics from Farm and Forest

by E. F. Lougee

Published by Plastics Institute, 221 N. La Salle St., Chicago, 1943

Price $2.00 **157 pages**

The story of the conversion of Nature's raw materials into synthetic products which serve mankind in an amazing variety of applications is dramatically related by this author. In his non-technical conversational style, he describes the broad markets into which synthetic plastics are entering today. The replacement of silk in parachutes, wool in blankets and clothing, and rubber in raincoats and tires are some of the topics considered. Present practices and future potentialities in the use of agricultural and forest products as sources for plastics are emphasized. Cotton, wood, lignin, cottonseed and oat hulls, nut shells, corncobs, soybeans, and skim milk are some of the raw materials discussed in detail. Although written, according to the preface, for those who know little or nothing about plastics, the easy readability of this book and the many bits of information contained in it which spring from the author's broad experience and many contacts in the plastics industry, will make it of general interest to his earlier reader audience in this magazine. G. M. K.

Plastics for Industrial Use

by John Sasso

McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, 1942

Price $2.50 **229 pages**

A handy manual of plastic materials and methods of molding and fabricating plastics succinctly describes the contents of this book. The author has gathered his material from manufacturers' literature and articles previously published in technical magazines. Chapters on comparative properties, molding methods, design of plastic parts, and machining and finishing operations are followed by specific discussions of phenolic, urea, acrylic, polystyrene, vinyl, vinylidene chloride, cellulose acetate and acetate butyrate, ethyl cellulose, laminated plastics, and plywoods and adhesives. A list of trade names, suppliers and molders completes this engineer's look at things plastic. G. M. K.

How to Read Electrical Blueprints

by Gilbert M. Heine and Carl H. Dunlap

Industrial Div., American Technical Society, 850 East 58th St., Chicago, Ill., 1943

Price $3.00 **318 pages, illustrated**

Due to the diversified character of the work performed and the machinery used in the electrical field, this text divides its subject into 8 branches, each having its own type of blueprint. Considerable space is devoted to symbols which are pictured side by side with the various pieces of apparatus which they represent, making a virtual dictionary and easy reference. Fundamental circuits have been selected to represent each branch and their operation illustrated and explained. Questions, answers and a quiz included at the end of each section serve as a source of information and as a check by the student on his work. The text is intended for the beginner but should be useful to the electrical worker as a reference book.

★ "MANUAL OF EXTRUDED PLASTICS," PUBLISHED by R. D. Werner Co., Inc., 380 Second Ave., New York ity, is an excellent treatise on plastics. Starting with the structure of specific plastics and with a brief description of each, the manual continues through the various methods of forming to machining and welding, with an explanatory glossary of terms. Numerous tables include a general properties chart, specific gravities of materials, etc. Several pages are devoted to standard shapes. The manual is limited in its distribution. Price $5.00.

★ "EXTRUDED PLASTIC TUBING AND SHAPES" HAS been prepared by the Thermoplastic Division of the Society of the Plastics Industry, Inc., 295 Madison Ave., New York City, to provide a ready source of information on available continuous extruded plastic tubings and related products for various branches of the Government and engineers interested in such applications. Tubing, pipe and fitting sizes are recorded under those companies now producing them and a directory of extruders represents all companies reported to operate extrusion equipment. Lists of materials and trade names are included and a tabulation of available shapes. The catalog is based on questionnaire returns and gives a fairly accurate picture as to the availability of these products. Price $1.00.

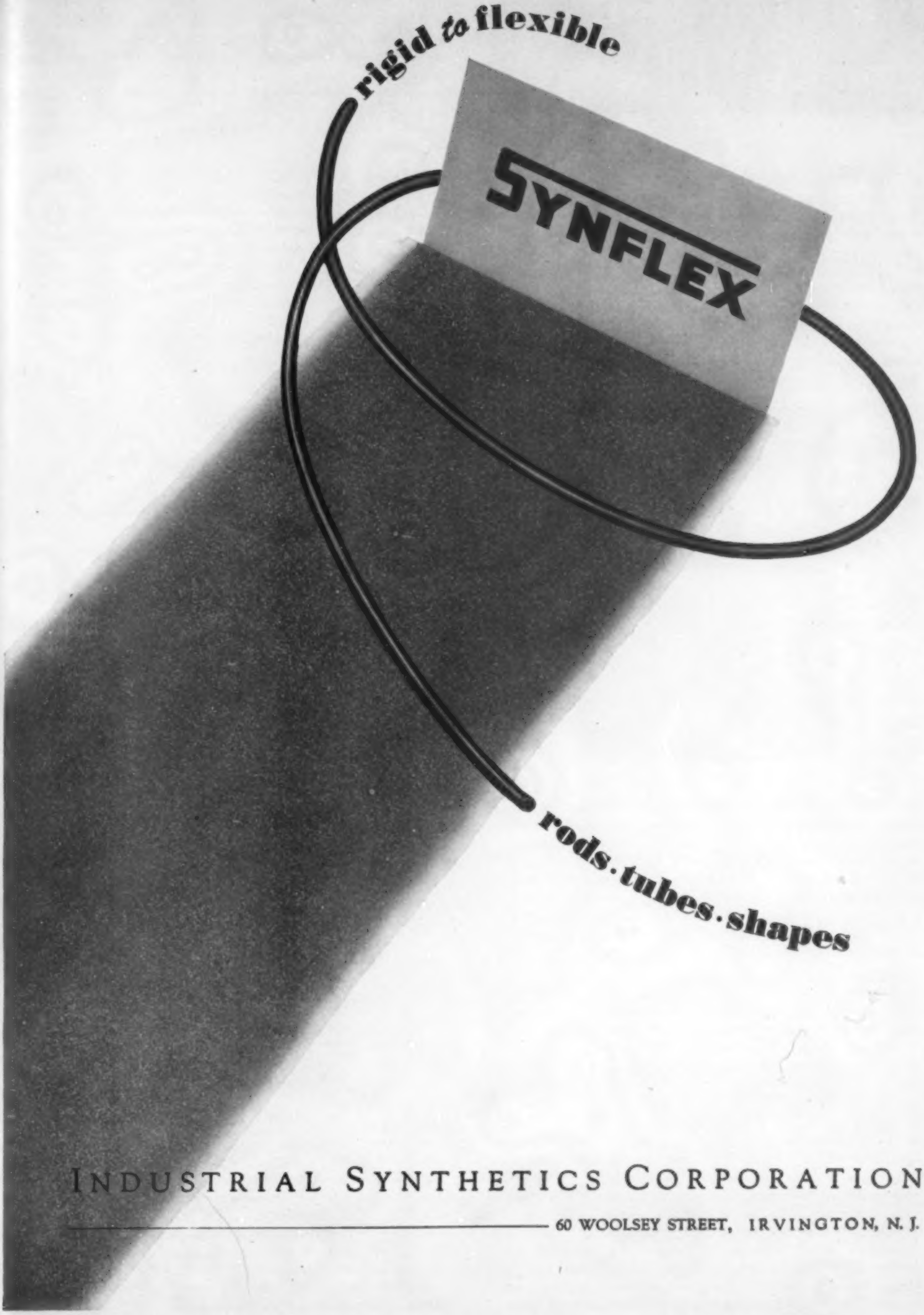
★ "AIRCRAFT PLYWOOD AND ITS FINISHING REquirements," Manual No. 2, published by Ault & Wiborg Corp., 75 Varick St., New York City, gives thorough and detailed information on this subject. The development of new techniques and changes in Government specifications have been taken into account in the compilation which is based on all information available to date.

★ A TECHNICAL BULLETIN ON INCREASING WATER resistance of polyvinyl alcohol coatings, issued by the Electrochemical Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., describes the methods for reducing water sensitivity of these coatings through the use of thermosetting resins, drying oils and certain chromium compounds.

★ "BATTLENECKS," THE THIRD BOOKLET IN THE "Tremendous Trifles" series published by the U. S. Army Ordnance Dept., Pentagon Building, Washington, D. C., is a challenge to all men on the production front to exercise their initiative and ingenuity in eliminating "battlenecks." Forty-five citations of men who have made marked contributions to machine, material and manpower efficiency include descriptions of the effectiveness of their applications.

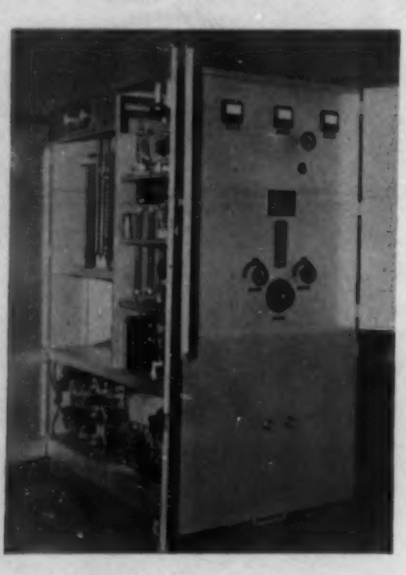
★ THE NATIONAL BUREAU OF STANDARDS, WASHington, D. C., has issued its fifth edition of "Douglas Fir Plywood," Commercial Standard CS45–42, which has been accepted by the trade as its standard of practice for new production beginning Nov. 16, 1942. A list of those who have accepted the rulings is included. Price 10 cents. Supt. of Documents, Government Printing Office, Washington, D. C.

★ THE STORY OF "TYGON," A CORROSION-RESISTant construction material, is told in Bulletin 1620, published by the United States Stoneware Co., Akron, Ohio. Its uses, qualities and data on chemical resistance are included in an attractively illustrated 16-page brochure.


rigid to flexible
SYNFLEX
rods · tubes · shapes

MACHINERY and EQUIPMENT

★ THE PRINCIPLE OF HIGH FREQUENCY ELECTRO static heating has been applied for the first time to the processing of non-metallic substances in a Thermex unit (model No. 15 shown below), developed by Girdler Corp., Louisville, Ky. The unit has two general purposes: heating uniformly at a rapid rate, and bringing about chemical reactions. Tested applications include drying of paper, textiles, tobacco and ceramics; polymerization of thermosetting resins, curing of rubber sections, binding granulated cork, gluing, killing infestation, and others. The equipment is said to be particularly suited to wood industries and especially for the resin bonding of plywood.



★ FOR CLEANING FLOORS IN INDUSTRIAL PLANTS or wherever grease may collect, Fibre-Tex, a sweeping compound recently developed by Lacey-Webber Co., Kalamazoo, Mich., is claimed to be free from the danger of fire and spontaneous combustion usually inherent in materials of this type. The product is said to be highly absorbent of oils and grease and to have an active cleaning effect upon floors where consistently used, making safety stripes and floor markings plainer as well as generally improving plant housekeeping.

★ FROM TINNERMAN PRODUCTS, INC., COMES AN announcement of a new angle anchor speed nut for right-angle blind attachments on junction box covers, switch box covers and similar assemblies. The fastening consists of a self-retaining "U" type speed nut snapped over the short leg of the right angle bracket, and is interchangeable with other angle anchor lock nuts. It is available in 86°, 90° and 94° angles.

★ A FOAM DEVELOPMENT FOR PROTECTION against alcohol fires has been produced in Alcofoam powder, by American-LaFrance-Foamite Corp., Elmira, N. Y. Poured into any single powder generator and applied through fixed connections on storage tanks, or through hose and nozzle, the powder creates a foam which acts as an air-tight blanket consisting of millions of minute bubbles of carbon dioxide gas. The foam floats on the liquid surface, completely cutting off the supply of oxygen necessary for combustion and, according to the manufacturer, coats and insulates any liquid or solid burning surface.

★ SPEEDY REFRIGERATION FOR LABORATORY work is offered by American Instrument Co., Silver Spring, Md., in their dry-ice cabinet intended for use where expensive mechanical refrigeration would not be justified. Two temperature ranges are available with constancies within $^1/_2$° F.; 0° F. to minus 90° F.; and 220° F. to minus 90° F. The cabinet is portable and ready for use upon packing with dry ice and plugging cord into current.

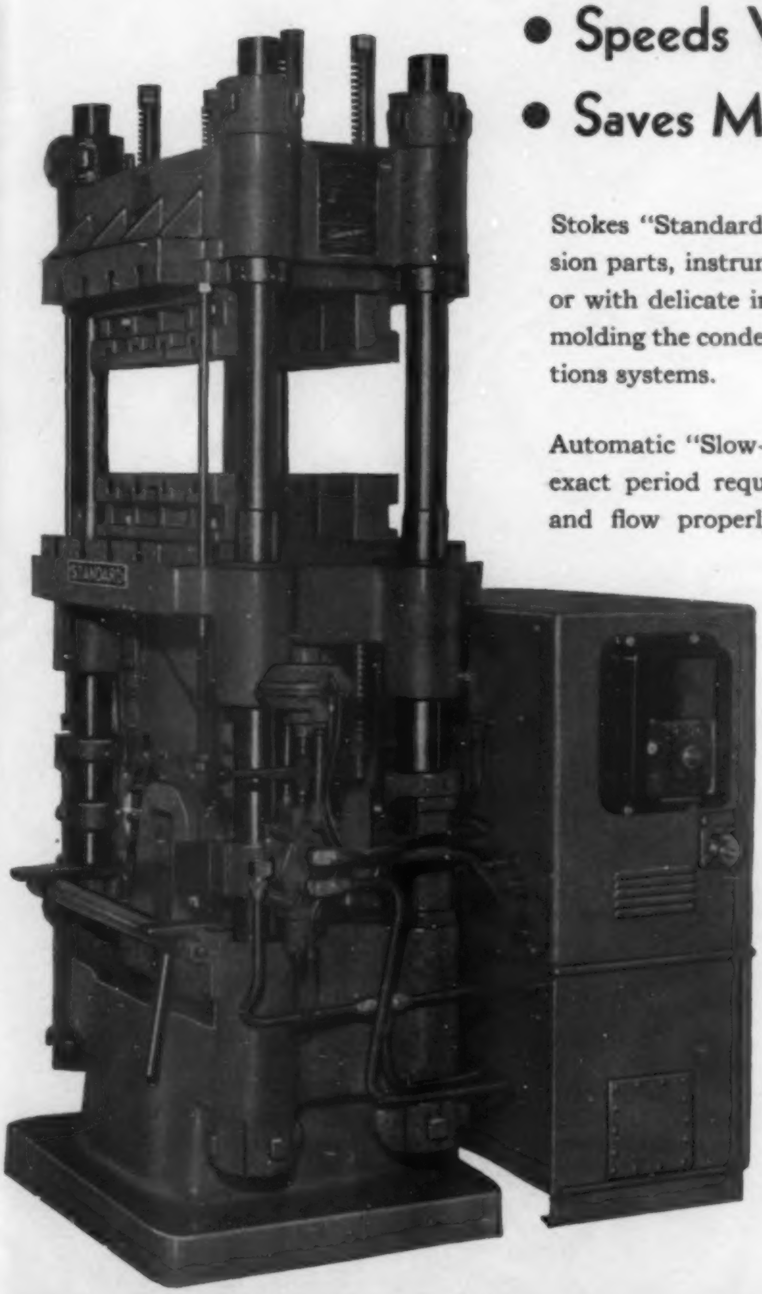
★ NEED FOR A SMALL PORTABLE UNIT TO ELIMINATE gases and fumes from closed-in places is reported to have been met by the Octopus Jr., an exhauster and blower made by Chelsea Fan & Blower Co., Inc., Irvington, N. J. The blower is powered by a $^3/_4$-h.p. ball bearing motor, has newly developed heavy steel wheels, sucks or blows 2,000 c.f.m. It operates in any position, weighs only 70 lb., and is small enough to be hung into a manhole. Equipped with adapters for three 4-in. nozzles or four 3-in. nozzles for flexible hose. Four-inch metal hose of 20 ft. lengths will exhaust 250 c.f.m.; 3-in. hose, over 200 c.f.m.

★ SLEEVES AND APRONS FOR FACTORY WORKERS exposed to hazardous factory operations are being manufactured from a material known as Ply Garb by the Milburn Co., Detroit, Mich. The cloth is of featherweight, flexible plastic laminated cotton and is sufficiently sturdy to resist tears and cracking. It is claimed to be flame-proof, a very important feature in preventing injury from spontaneous magnesium fire, and also offers protection against water, acid, alkalis and chemicals of all kinds. Cut for the maximum comfort and freedom of movement, the aprons are available in full-front and split front models, with adjustable shoulder straps. The sleeves feature air vents to guard against excessive perspiration.

★ DEVELOPMENT OF A LOCKING SYSTEM FOR threaded inserts and studs devised by Jose Rosán and manufactured by Bardwell & McAlister, Inc., Hollywood, Calif., for war industries only, offers a unit claimed to have maximum fastening strength and permanency for soft metals, plastics and wood. A simple ring with serrations inside and out is forced into place over interlocking serrations built into the stud head, making a tight fit flush with the surface of the material. Tension tests have demonstrated the insert to be stronger than a bolt screwed into it when installed in magnesium or aluminum alloy. Torsion values are increased by the great number of teeth in the locking ring, which broach their way into the surrounding material. The unit is reportedly easy to install (see above) and may be removed without injury to material.

"SLOW-CLOSE" *Proves* ITS VALUE in Molding Condensers

- **Reduces Rejects to a Minimum**
- **Assures Uniform Dielectric Strength**
- **Speeds War-Time Production**
- **Saves Material, Labor, Mold Wear**



Stokes "Standard" Presses are ideal equipment for molding precision parts, instrument housings, parts with thick and thin sections or with delicate inserts, etc. . . . they are preferred equipment for molding the condensers used in radio and other types of communications systems.

Automatic "Slow-Close" times the final closing of the mold to the exact period required for the material to plasticize completely and flow properly. The action repeats, automatically, exactly, indefinitely. It eliminates human error, produces moldings of closest uniformity, with very few rejects. Together with Automatic Cycle Control it enables unskilled labor to do the finest precision work, enables one operator to run several presses, affords more heats and produces more parts per hour.

Improved Stokes "Standard" Presses are proving their advantages in war work of many kinds. These advantages will prove of equal value in the post-war economy. For more information write for new Catalog No. 427.

F. J. STOKES MACHINE COMPANY
5934 Tabor Road, Olney P.O., Philadelphia, Pa.
Representatives in New York, Chicago, Cincinnati, St. Louis, Cleveland, Detroit
Pacific Coast Representative: L. H. Butcher Company, Inc.

F.J.Stokes MOLDING EQUIPMENT

FJS Est. 1895

IN THE NEWS

★ THE SPRING MEETING OF THE SOCIETY OF THE Plastics Industry is to be held at the Edgewater Beach Hotel, Chicago, Ill., on May 13 and 14. While the sectional meetings held during recent months both in Canada and on the Pacific Coast have attracted large attendances, the national character of the Chicago conference would seem to assure an even wider participation. Elmer E. Mills, president of Elmer E. Mills Corp. of Chicago, is chairman of the committee on arrangements.

Theme of the meeting will be, "Plastics since Pearl Harbor," with emphasis upon the results of different types of plastics under conditions encountered on our far-flung battle fronts.

Arrangements for speakers are now being made and the complete progam will be announced at an early date. However, it is possible to outline some of the varied subjects on the agenda. These include: high frequency heating and molding, low pressure laminates, phenolics, melamine, saran, cellulosic materials, processing methods, taxes and labor conditions.

In addition to the general sessions, there will be divisional meetings designed to bring together individuals within specialized branches of the plastics industry for round-table discussions of their special problems. Members of the armed services will be present to discuss with the industry problems relative to plastics which have developed since the country went on a total war footing and to indicate war supply problems still remaining to be solved. Representatives from other Government departments will also attend to discuss with members of the industry regulations affecting prices, labor, materials, etc.

★ DISCOVERY OF A NEW TYPE PLASTIC WAS DISclosed with an announcement by the Dow Chemical Co., Midland, Mich., and Corning Glass Works, Corning, N. Y., of the incorporation of the Dow-Corning Corp., a jointly owned subsidiary organized for the manufacture and sale of silicon resinous materials. Several years of research in the laboratories of the parent companies, including projects conducted at the Mellon Institute, were spent in evolving this plastic.

The introduction of the inorganic mineral element, silicon in this instance, has claimed to have solved to a considerable extent one of the greatest problems of present-day plastics, i.e., their lack of ability to withstand extreme heat. Silicones, which is the term given to the various forms of the new plastic, are said to have a melting point close to 500° F., a decidedly new high for plastics. This means they should be suitable for use in electrical insulation where extreme heat may develop. The new product is also claimed suitable for use in liquid form and reportedly will neither thicken as the temperature drops nor thin out with a high rising temperature, making it useful for fighting planes.

Chemically the new materials are understood to result from combining silicon dioxide with the methyl or ethyl groups of molecules derived from alcohols, or with ethylene chloride or phenol from coal tar. Different properties are given to the materials by using both the straight chain or the ring type organic molecules with the silicon.

While the silicon materials have not been fully tested and the process of manufacture is complicated, it is expected that with the ironing out of minor problems the limitations which have of necessity attached to plastics up to the present will be eliminated by inclusion of properties belonging to the inorganic materials.

Officers of the newly formed Dow-Corning unit which will manufacture its products in Midland, Mich., are: president, Dr. E. C. Sullivan, vice-chairman of the Corning board of directors and director of research; vice-president and general manager, W. R. Collings, production manager of the Cellulose Products Div. of the Dow company; secretary, E. C. Britton, Dow's director of organic research; treasurer, C. D. LaFollette, of the Corning company.

★ THE 14TH ANNUAL PACKAGING CONFERENCE, sponsored by the American Management Association, will be held at the Hotel Astor, New York City, on April 13–16. Wartime problems and how packaging has withstood the tests of war will be the underlying topics of discussion. The 13th Annual Packaging Exposition is to be held along with the conference.

★ A COMPLETE REVIEW OF INJECTION MOLDING of thermosetting materials from the early transfer molding technique developed by Frank Shaw through present-day developments such as jet molding and heatronic molding was delivered by Charles Norris of Bakelite Corp. at the monthly meeting of the Plastics Sales Engineers Association held March 15 at the Yale Club in New York City. (The text of the speech as well as photographs of the slides shown by Mr. Norris appear on p. 73 under the title, "Transfer molding of phenolic material.")

The next monthly dinner and meeting of the group will be held April 12 at the same place. Mold design and Dow Chemical Co.'s new material, Styraloy, will be the topics of discussion.

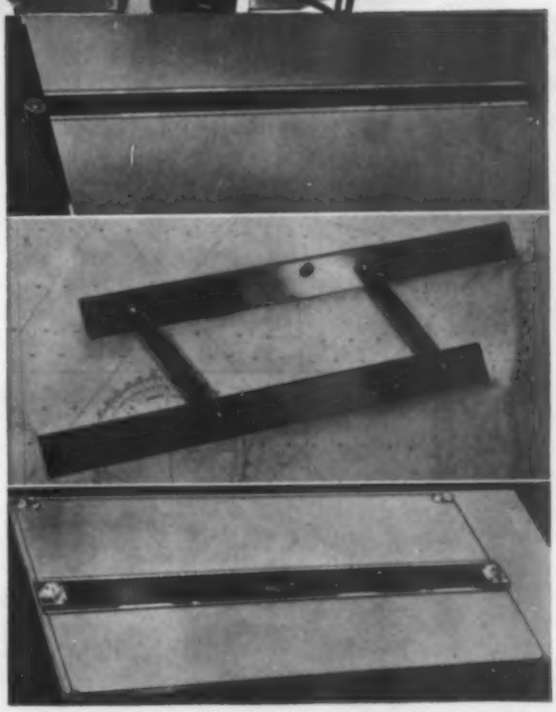
EDGAR M. QUEENY

CHARLES BELKNAP

★ EDGAR MONSANTO QUEENY, FOR 15 YEARS PRESIdent of Monsanto Chemical Co., has been elected chairman of the board, a position vacant since the death in 1933 of his father, John Francis Queeny, founder of the company and its first president. Charles Belknap, chairman of the executive committee and executive vice-president, was elected president and will continue his duties as chairman of the executive committee. Mr. Belknap became a member of the board of directors and a vice-president of the company in 1929 when the Merrimac Chemical Co., of which he was president, was purchased by the Monsanto company in an expansion program.

★ FROM LONDON COMES THE NEWS THAT THE metal and enamel lion badge worn by the members of the British Legion is shortly to be replaced by a plastic model in similar design. Four sample badges are now being made up, one of which will be chosen by the Legion's national executive. No more special badges are being made for honorary members, and there are to be no more miniature or tiepin badges until after the war.

★ PLASKON CO., TOLEDO, OHIO, HAS ANNOUNCED the following changes in personnel: W. N. Shepard, asst. sales manager of commercial products, continuing as advt. manager; E. B. Stratton, Jr., assigned to Washington, D. C., assisting Carleton Ellis, Jr.; R. M. McGee, special sales department work covering adhesive autoclave operations and low-pressure laminated work over the entire U. S., headquarters in Toledo. Adhesives and molding material representatives: H. W. DeVore—Central Southern territory; C. B. Wing—Canada, New York, Northern Pennsylvania, New England in part, headquarters in Rochester; J. A. Joyce—to include Long Island. Molding material representatives: James Ferguson—Ohio, Michigan, Eastern Indiana, headquarters in Toledo; H. S. Vandersall, sales correspondence with headquarters in Toledo; P. G. Hubbard—additional accounts in New England. H. T. Yaryan will handle adhesive sales and service correspondence in Toledo; C. E. Walker will handle adhesives in Michigan, Ohio and Indiana with headquarters in Toledo. (*Please turn to page 116*)



HERE'S some friendly help to the engineer in his own personal work. By using Formica for numerous purposes in the machines they design engineers have often found the going easier, the product better. Now this same modern, laminated plastic material is offered in the form of T squares and other drawing instruments for use in the draughtsman's work—instruments that wear like iron, hold together and endure for years, never change in dimensions or appearance. They are beautiful instruments when you get them and they remain that way.

They are manufactured from Formica materials by the Engineering Sales Company, Sheboygan, Wisc.

ARMY E NAVY

FORMICA

Formica has received the Army-Navy "E" Award for Excellence in Production.

THE FORMICA INSULATION CO. • 4638 SPRING GROVE AVE. • CINCINNATI, O.

★ THE SOCIETY OF PLASTICS ENGINEERS SPONsored a War Production Clinic held on March 11 at the Medinah Club in Chicago, Ill. Among the panel sessions were three on plastics featuring: wood, paper and fabric laminates; rubber and rubber substitutes; and extruded and molded plastics.

The first of these panel sessions on plastics opened with a general discussion of properties and processing problems. Among other uses, the good vibration resisting qualities of resin-impregnated glass fabric were discussed, together with its use in antenna masts as a material preferable to impregnated paper or fabric. Also brought out were the possibilities for using high frequency alternating currents to cure laminates when under pressure in the press. It was pointed out that this method is excellent for the alternate heating of compression molded thermoplastic resins since it reduces the molding cycle. Bonding of laminates with steel was discussed as well as the use of lignin cellulose for impregnating material to be used as laminates. In relation to the former, a bonding material developed by the Chrysler Corp. was mentioned which under test showed that the phenolic would break before separation occurred between it and the steel.

Lt. A. D. Fowler, S.G., of the U. S. Navy, talked on uses of plastics by the Navy and of procurement procedures. He said that the Navy bought only from recognized sources on competitive sealed bids, the decisions being based upon best available sources and delivery requirements and not on lowest prices. Advisory service is available to all manufacturers on various procurement problems in conjunction with WPB.

The panel on rubber and rubber substitutes was opened by a talk on the availability of rubber and rubber-like substitutes by Dr. H. A. Winkelmann, technical director of the Dryden Rubber Co. Mr. Winkelmann described the general rubber problem and synthetics in use. Styroloy, a rubber-like substitute manufactured by the Dow Chemical Co., was discussed.

W. T. Cooper, technical representative of Bakelite Corp., introduced the discussion leaders of the panel on extruded and molded plastics. Included in the ensuing discussions were jet molding of thermosetting resins, tolerances possible on extruded tubing and plating of plastics.

W. A. Johnson, research engineer of the International Harvester Co. addressed the luncheon guests on "Save those tools and keep production going." A motion picture was shown depicting the methods of salvaging and rebuilding tools. The sound and color motion picture, "This Plastic Age," produced by MODERN PLASTICS magazine, was featured as the finale of these interesting panel discussions.

★ "SYNTHETIC RUBBER AND RUBBER-LIKE MATErials and their availability," was the subject of an address by Dr. H. A. Winkelmann, technical director of Dryden Rubber Co., before the S.P.I. meeting held at the Merchants and Manufacturers Club in Chicago, Ill., on March 5.

Dr. Winkelmann discussed in detail the properties and advantages of the various synthetic rubbers, including Thiokol, neoprene, butadiene rubber and butyl rubber. He mentioned vegetable oil elastomers such as the Norepol group, obtained from soybeans, as an important source of synthetic rubber substitutes. Vinyl elastomers, which have excellent rubber-like characteristics when used with proper plasticizers and show promise as substitutes or for applications for which other rubber-like materials are unsuitable, were also described by the speaker.

★ STYRALOY 22, A THERMOPLASTIC DEVELOPED BY Dow Chemical Co., Midland, Mich. is described in a recent technical sales bulletin which lists its properties and fabrication techniques. This material is a synthetic thermoplastic resin of the hydrocarbon type, and it is said to possess good low-temperature flexibility, excellent electrical properties and unusual stability to corona discharge at elevated temperatures. Its general properties suggest these applications: an insulating material for airplane ignition cables, intermediate frequency coaxial cables and other general types of cables and many mechanical applications where flexibility is required.

★ THE DETROIT SECTION OF THE SOCIETY OF PLAStics Engineers enjoyed an excellent dinner and program on February 25 at the Rackham Memorial Bldg. Colonel George E. Strong, of the U. S. Army Air Corps, gave a very interesting talk on aircraft and plastics. Carl E. Holmes, of the Engineering Specialties Corp., delivered an enlightening talk on mold design.

★ DURING A.S.T.M. COMMITTEE WEEK, HELD IN Buffalo, N. Y., in the first week of March, a number of important actions on standards, research, purchase specifications, etc., were taken by the technical groups attending and by those committees meeting simultaneously in other industrial centers.

Committee D-9 on Electrical Insulating Materials and Committee D-20 on Plastics, which held their two-day meeting in New York City, had 5 new specifications to offer to the Society for publication. The specifications submitted for action cover two types of shellac (pure garnet and pure button lac), laminated thermosetting material, vulcanized fiber, and low and medium-voltage pin-type lime-glass insulators.

In the specification of laminated materials, the types and grades are classified in accordance with the sheet material employed in their manufacture and the electrical, mechanical and heat-resisting characteristics of the finished products.

The extensive revisions effected last year in the methods of testing molded materials were issued as a complete new tentative standard. Changes proposed at the March meeting relate to the resistivity requirements. Additional changes will be recommended by the committee in the tests for sheet and plate materials so that the tensile strength specimen will correspond to those developed by Committee D-20. Similarly, the compression tool used in the D-20 methods will be required.

Committee D-11 on Rubber Products approved a classification of material and synthetic rubber which is being published in the latest compilation of A.S.T.M. Standards on Rubber Products. The first definite action to be taken by the committee involving synthetic rubber wire insulation is the submission for vote of two new tentative specifications for synthetic jackets for wire, both involving neoprene, one for light service and the other for heavy-duty service. Upon approval by the committee it will be submitted to the Society for publication. A new specification for polyvinyl chloride type insulation is also to be voted.

★ WE REGRET TO REPORT THE DEATH ON FEBRUary 16 of Harry Wilson, manufacturers' representative in the Detroit automotive field for approximately 20 years. Mr. Wilson represented among other well-known firms, Mack Molding Co., L. S. Brach Mfg. Corp. and Standard Emblem Co.

Sorry!

★ IN THE HEATRONIC MOLDING ARTICLE BY V. E. Meharg in the March issue of MODERN PLASTICS, the 5th listed advantage of heatronic molding on page 90 refers to *compression* molding and accordingly should read: "5. For the first time it becomes commercially practical to compression-mold pieces thicker than $^3/_8$ of an inch from thermosetting materials."

Due to requests for Mr. Meharg's article, MODERN PLASTICS has made available for general distribution a limited number of reprints. Readers may secure copies by writing to MODERN PLASTICS, Inc., 122 E. 42nd St., New York City, on their own letterheads, enclosing 10 cents postage to defray charges.

★ ADDITIONAL INFORMATION RECEIVED FROM Sperzel Sanitary Seat Co. (March issue, p. 60) reveals that several plastic materials are incorporated in their product. Covering for seat supports is Tenite or Ethocel tubing, extruded by Southern Plastics Co. in $^1/_2$-in. ID, .020-in. wall thickness. Pads are molded of Bakelite or Indur by Plastics, Inc. Housing cover of the spring raising mechanism is molded by the same firm of Plaskon, and A. E. Neely Co. molds its phenolic base.

★ PENN FIBRE & SPECIALTY CO. INFORMS US THAT the canvas laminated phenolic material used in the mallet shown in March, p. 82, is a phenol fiber supplied by Taylor Fibre Co.

Washington Round-Up

Current news, Government orders and regulations affecting the plastics industry, with analyses of the plastics situation

ACT NOW ON YOUR MANPOWER PROBLEM

The Government isn't fooling when it talks about putting more than 11,000,000 men into the armed forces. All chatter from the opposition is mainly fireworks. Informed authorities are guessing that the number will be even higher. In wartime, military leaders have a way of getting what they want, and their first requirement is men. The problem of supply and water transport is, of course, tremendous, but while most generals will take a chance on supplies, few of them will take chances with insufficient manpower. Also it is well to remember that a large portion of the armed forces will never get overseas and won't need water transportation to support them.

The significance of this is that as time goes on the manpower situation will get tighter and tighter. Each war industry, including agriculture, thinks it is the most important. From powder makers to laundry workers there are many employees who have legitimate claims as indispensable workers. Local draft boards will become more weighted down with requests for deferment of key men. With all this competition for men, it behooves plastics manufacturers to get on the job immediately and survey their working force with a powerful lens. There is no time to lose. In many areas, fathers of military age will start going some time in May, according to good authorities. Top notch company officials should be given the job of supervising replacement schedules and preparing training programs.

To enable industrial plants to indicate the order of importance of various employees subject to the draft, Selective Service has developed a Replacement Schedule which should be made out from data developed in preparation of the Manning Table. Information regarding the Replacement Schedule can be obtained from the liaison officer of the local board. When the Replacement Schedule is accepted by Selective Service, it will remain in effect for a period of six months from the time of acceptance. One month prior to the end of this six-month period, a new Replacement Schedule should be presented to Selective Service.

The chemical and plastics industries do not want to be put in the position of demanding priorities in manpower over other important war industries, but they are in a tough spot. Without chemicals there would be no plastics; without plastics, the Army and Navy would be in a tough spot. But here is the situation: around 250 chemical plants, including additions, are yet to be completed this year. Where the workers are to come from is still a mystery. Synthetic rubber, petroleum and chemical workers come mostly from the same labor pool, and it is difficult to refill that pool with unskilled workers. Surveys are being made to ascertain the exact situation. Many employers have been slow in answering their questionnaires and the exact status of their employees is not yet known. If they will hurry it up, they will be doing the entire industry a favor and helping to speed up plans for obtaining needed workers.

The chemical industry is particularly affected because of general inability to obtain workers from other branches of industry except those mentioned above. It would take too long to train them. Yet local boards are almost certain to take another large slice out of this specialized labor pool. The best that employers can expect is reasonable assurance that they can keep their supervisors and assistant supervisors to help train new persons. These men are the most vital cogs at present, and draft boards should be carefully informed on this point by employers making requests for deferment. So far, at least, the strictly scientific men have been fairly well taken care of by local boards, but they must be guarded carefully. There will be no new chemists coming into the field after the universities close this present term.

Insofar as the plastics molding, laminating and fabricating plants are concerned, the manpower problem is critical and will get more so, but replacements should not be so difficult to obtain. One large manufacturer reports that he is now employing 80 percent women in comparison to 60 percent in normal times. Then, too, there is a possibility that split-shifts can be worked out to encourage professional men, lawyers, doctors and others to work four hours a day after their regular working hours. In England this process has been developed extensively. A classical example is given of banking house employees who worked every Sunday in an arms plant in order to give the regular workers a day off.

Lengthening hours of work always looms as a possibility in any manpower shortage situation, but the Government seems loath to encourage anything beyond the 48-hr. basis. Needless to say, it is useless for an employer to come to the Government seeking aid in any critical area unless he is already on a 48-hr. basis.

Help for training new workers can be obtained direct from the War Manpower Commission by direct application. The Training Within Industry branch offers four training programs as follows:

1. Job Instruction Training teaches employees how to break in new workers on the job.
2. Job Methods Training teaches workers how to improve and simplify methods of doing a job.
3. Job Relations Training shows supervisors how to work with people to gain cooperation. (*Please turn to next page*)

R. L. VAN BOSKIRK

With this issue of Modern Plastics, R. L. Van Boskirk takes over the management of its Washington Bureau from G. T. Kellogg, who is on leave of absence serving with the Armed Forces.

Mr. Van Boskirk is a graduate of Northwestern University's School of Journalism, and has served an apprenticeship on numerous small-town newspapers, both as reporter and printer. For the last fifteen years he has been covering Washington news for *Nation's Business* and doing other free lance editorial work.

4. Training of Training Directors gives intensified coaching in how to operate and improve complete, plant-wide training programs.

Employers may get further information by getting in touch with their nearest TWI office or by writing C. R. Dooley, Director, Training Within Industry, War Manpower Commission, Washington, D. C.

PLASTICS MOLDING MACHINERY ORDER AMENDED

Concurrent with the issuance of the Thermoplastic Order, WPB issued an amended Plastics Molding Machinery Order (L-159). The principal point of this new order is a prohibition on the delivery and acceptance of fixtures for new or used parts or groups of parts for plastics molding machinery. Fixtures include: cylinders, feed screws, straight heads, cross heads, jet attachments, temperature control units and molds. This means that no one may begin to manufacture, or deliver after completing the manufacture of, any mold without specific authorization by the War Production Board, which may be obtained by filing an application on Form PD-741 with the War Production Board, Chemicals Division, Washington, D. C., Ref. L-159. *This amended order covers used as well as new plastics molding machinery and fixtures.*

It has been pointed out that some misunderstanding has arisen in regard to L-159 about intra-company deliveries. The prohibition and restrictions of L-159 apply not only to deliveries of machinery and fixtures to other persons including affiliates and subsidiaries, but also to deliveries from one branch, division or section of a single enterprise to another branch, division or section of the same or any other enterprise under common ownership or control. Definition of plastics molding machinery was clarified in the amended order by adding "ceramic injection molding presses or machines capable of being used for plastics" and "plastic tablet preforming molding presses or machines."

CONTRACT RENEGOTIATION SPEEDED

A joint directive, designed to expedite clearance of cases involving renegotiation of war contracts, has been signed by the Secretaries of War, Navy and the Treasury and the Chairman of the Maritime Commission. The new arrangement involves a delegation of the powers of each of the three Secretaries and the Maritime Commission to one another. Over-all review of the war profits of a contractor or sub-contractor is handled by the department having the predominant monetary interest although the contractor is doing business for two or more departments. The Secretary of the department handling the renegotiation is now empowered to conclude an agreement with a contractor and sign it on behalf of the other departments with which the contractor may have business, such signature being binding on the other departments.

FORMALDEHYDE FROM ETHYL ALCOHOL

A process for producing formaldehyde from ethyl alcohol has been developed in India but production on a laboratory scale has shown that the yield must be increased to make the process practical, according to trade reports reaching the Department of Commerce.

The maximum yield of formaldehyde obtained was 44 percent. This must be increased by 10 to 15 percent to make the process competitive with other methods. The price of imported and domestic methanol in India precludes its use for the production of formaldehyde.

CRESYLIC ACID CEILING

A maximum producers' price of 72.8 cents per gal. for imported Grade A cresylic acid has been established by OPA. Practically the only source of imported cresylic acid is Great Britain, which until now has been exporting to American users mainly Grade B of the chemical. However, a limited amount of the higher grade is now being made available to purchasers in this country.

The action, taken in Amendment No. 3 to MPR No. 192 (Imported Cresylic Acid), recognizes a 2.8 cents per gal. differential between the Grade A and Grade B grades, and sets the same ceilings established over the chemical by British price control.

THERMOPLASTIC SCRAP CEILING

An average reduction of about 25 percent below March 1942 market levels has been ordered by OPA through issuance of MPR 345, March 16, 1943. Under this regulation, dollars and cents ceiling prices will hereafter govern the eight major types of thermoplastic scrap. The new ceiling is fixed upon the average level prevailing in the industry for 1941.

The eight types of thermoplastics covered are cellulose acetate and cellulose nitrate, plastic grade; cellulose acetate butyrate; methyl methacrylate; polystyrene; polyvinyl chloride; copolymers of vinyl chloride and vinyl acetate; and polyvinyl butyral. Excluded from the new regulation are motion-picture, x-ray and photographic film scraps, plastic sheets laminated to non-plastic materials, and gummed tapes. These materials are treated separately because of major differences in marketing methods. Sales of synthetic rubber, which might be considered thermoplastic material, also have been excluded. Certain types of thermoplastic materials recovered by the manufacturers and sold as "seconds" are also excluded.

Copies may be obtained from the Office of Price Administration.

THERMOPLASTIC ORDER M-154 REVISED

A sweeping revision of Thermoplastic Order M-154 was issued on March 26 by WPB. Approximately 250 new articles were added to the list of products which may not be manufactured, regardless of preference rating (see insert opposite page 86).

VARNISHED CAMBRIC AT CAPACITY PRODUCTION

Production of insulating varnished cambric, used chiefly for wrapping Navy cables, is at 100 percent of capacity and projected requirements for the year apparently will be met, according to the Chemicals Division of WPB. But there are many factors giving concern to the industry. Decreasing availability of castor, oiticica and tung oils makes it necessary to use treated linseed oil wherever possible. The glycerine supply is also limited.

It has been suggested that phenols might be replaced with vinyl resins. The supply of phenol resins is expected to increase in the next 60 to 90 days, but military requirements probably will offset this production. Supplies of cresylic acid and xylenols also are tight and the possibility of using metapara creson from savings effected in the laminating industry are discounted, since this raw material does not lend itself to production of satisfactory soluble resins for use by the insulating varnished cambric industry. Simplification of allocations by proper end-use definitions was urged by the Industry Committee.

STANDARD FORM TO SIMPLIFY CMP PROCEDURES

A single standard form of certification to replace other forms formerly required on delivery orders is another step in the progress made to simplify the Controlled Materials Plan procedures. CMP Regulation No. 7 provides that any delivery order may be validated by endorsing it, or accompanying the order with a certificate signed by the purchaser stating that he is meeting applicable WPB regulations. The earlier forms of CMP regulations 3, 4 and 5 may still be used if a purchaser so wishes, but the standard form will obviate the necessity of placing several different certifications on a single order in many cases.

SEEDLAC ALLOCATED

Seedlac has been placed under control through issuance of Allocation Order M-106. The order continues control of shellac, which is defined as lac of all grades including dry, cut, bleached and otherwise processed shellac, seedlac or other types of lac. The definition excludes such lac after it has been incorporated into protective or technical coatings or molding compounds, or after it has been mixed with a substantial quantity of other materials except chlorine, alcohol or other solvents, or has been made an integral part of some article such as electrical equipment.

This Navy nurse is Tough

THAT LITTLE RED BOX goes where the action is—and, to win its wings, it had to be light and *tough*. Metal? No—acetate plastic. Acetate for its exceptional lightness. Acetate because it can take a terrific beating—because it does not bullet-splinter—because it stays tough under wide ranges of temperature and temperature change.

IN LITERALLY HUNDREDS of ways, acetate plastic is serving the needs of war, as it will one day again (in ways undreamed of) serve the cause of peace. Injection-molded with speed and economy, its unique *combination* of advantages calls for your searching inquiry.

TO HELP YOU, we have information about cellulose acetate, based on our years of research as one of the nation's leading producers of cellulose derivatives. And, though we do not make plastics ourselves, we can refer you to the fabricators who are formulating with this exceptionally versatile material. Please address your letter to Department MP-43.

Aircraft First Aid Package molded of Celanese - Celluloid Corp.'s Lumarith by Elmer E. Mills, Inc., for United States Air Conditioning Co.

HERCULES
CELLULOSE ACETATE

★

TOUGH • FLEXIBLE • STABLE
LIGHTWEIGHT • ECONOMICAL • CLEAR

HERCULES POWDER COMPANY Incorporated **· WILMINGTON, DELAWARE**

Mechanical properties

(Continued from page 100)

notch sensitivity under alternating bending stresses than for those cut transversely at normal temperature.

The fatigue tests at subnormal temperature for cellulose acetate and cast and reinforced phenolics are not completed and the results will be reported at a later date. However, the fatigue limit for one type of laminated phenolic, reinforced with a fine weave grade L was increased 32 percent at a temperature of −30° F. The cast phenolic has high notch sensitivity at normal temperature. A 60° circular notched specimen reduced the fatigue limit approximately 52 percent.

The laminated maple wood panels impregnated with phenolic resin and compressed 50 percent have a ratio of fatigue strength to specific gravity equal to that of forged 25ST aluminum alloy.

The fatigue limit for laminated maple panel A with a low resin content, and panel E, resin-paper bonded, were 13.3 and 26.6 percent higher, respectively, than for panel D with a high resin content. The strength-weight ratios for the former were 20.3 and 25.8 percent higher, respectively, than for the latter. The strength-weight ratio for notched specimens showed practically the same relation as the unnotched for these panels. The strength-weight ratio for non-compressed natural maple wood was equal to that of the phenolic impregnated and compressed maple wood panels.

These materials did not develop any heat when subjected to alternating bending stresses. A careful examination of the fatigue fractures in the phenolic-bonded panels indicated no weakness in the phenolic bond. The strength-weight ratios for yellow birch wood and impregnated compressed birch were 52 and 60 percent higher, respectively, than for hard maple wood. Sufficient material was not available to study the effect of speed.

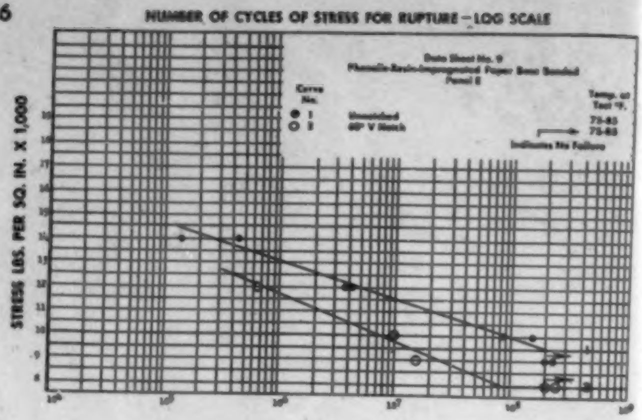
Impact tests—The results of Izod impact tests on notched specimens are reported in Table VIII.

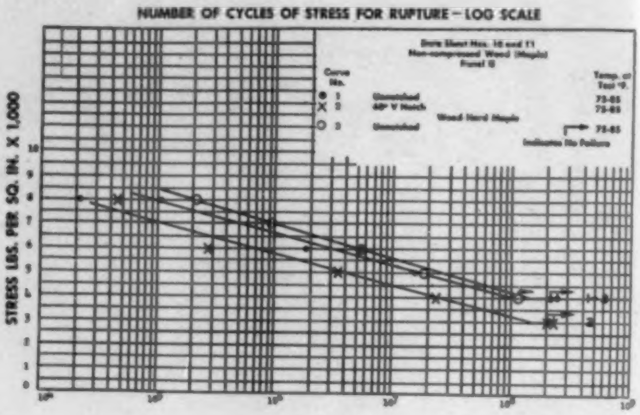
Miscellaneous tests—Results of tests of light transmission, rate of burning, water absorption and outdoor aging for some of the plastics are reported in Table IX

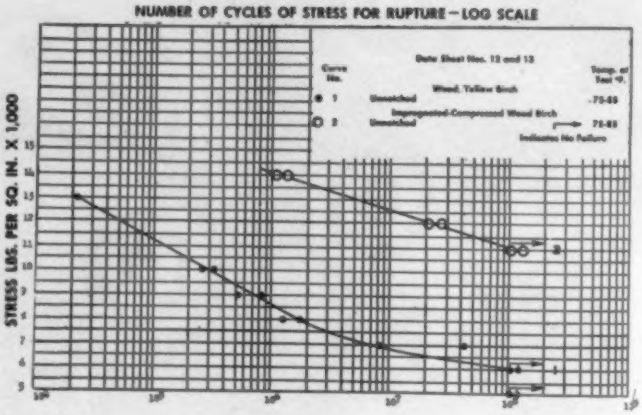
Characteristics of materials

Polyvinyl compounds—The vinyl chloride acetate copolymer "A" is more plastic than the "B" material. In tension the former reaches its ultimate strength before necking down sharply. The load drops rapidly to approximately half the ultimate load remaining there while stretching occurs until the specimen tears from the side or fails through slight de-

16

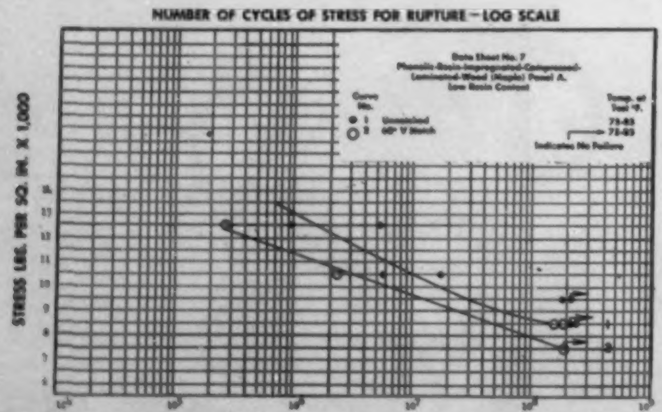


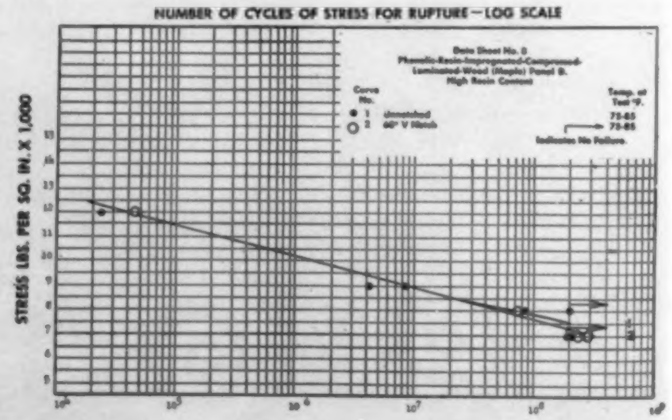




15, 16—*Stress-cycle diagrams in reversed bending, rotating beam*

15





TULOX TT REG. U.S. PAT. OFF.

HOLLOW ROD
made from Tenite II
HEXAGONAL · KNURLED · ROUND

TULOX TT REG. U.S. PAT. OFF.

Seamless
PLASTIC TUBING
made from Tenite II
Now available in a full range of sizes from 3/16" to **2½"** O. D.

Immediate shipment from warehouse stocks for War Production

NATIONAL DISTRIBUTION

JULIUS BLUM & CO., INC.
532-540 West 22nd Street, New York

CRANE CO.
836 S. Michigan Ave., Chicago

IN CANADA: Sole Licensees, **DUPLATE CANADA, LTD., PLASTIC DIVISION, OSHAWA, ONTARIO**

EXPORT: AMERICAN STEEL EXPORT CO., INC., 347 MADISON AVE., NEW YORK, N. Y.

fects which show up under stretching. The percentage elongation therefore varied widely, although the ultimate strength did not. As high as 90 percent elongation was observed at room temperature. It is felt that this value is probably indicative of the true value of elongation and that the lower values may be due to irregularities in material and testing. The necked-down portion was translucent. Measurement of elongation after fracture was not possible at −38° F. because the center section shatters. The "B" material does not neck-down or have as high elongation. Sufficient specimens of this material were not available for test to determine if the increase in elongation from 4 to 6 percent from +78° to −38° F. was due to temperature effect, variation in material or experimental error. Polyvinyl acetal plastic shows the same characteristics as vinyl chloride acetate copolymer "A" material in tension. However the ultimate strength is less but the elongation is greater and although decreasing temperature has a great effect, the elongation was comparatively high at −38° F. The stiffness data for these materials show the same trends as the tensile properties. The materials bent to 90° without fracture at all temperatures. Compression tests were not made since no sheet of greater thickness than 0.125 in. was available.

Cellulose acetate—The cellulose acetates "A" and "B" and the cellulose acetate butyrate exhibit tensile characteristics at room temperature as shown in Fig. 17. The stress reaches a maximum, drops off and then gradually increases as elongation increases up to fracture. The stress at which the first maximum is reached is a definite value for each material at a given rate of straining, increasing with higher rates. It is not dependent on the type of testing machine used. The same characteristics were found in compression but not in the bend and stiffness tests. In tension these materials do not neck-down sharply but elongate gradually over the entire reduced section. These materials bent 90° in the Olsen stiffness tests without fracture at all temperatures. The 0.5-in. bend specimens shattered at 0.8 in. deflection at −38° F. but were not fractured at room temperatures. The cellulose acetates and acetate butyrate are particularly characterized by a very marked increase in strength and decrease in elonga-

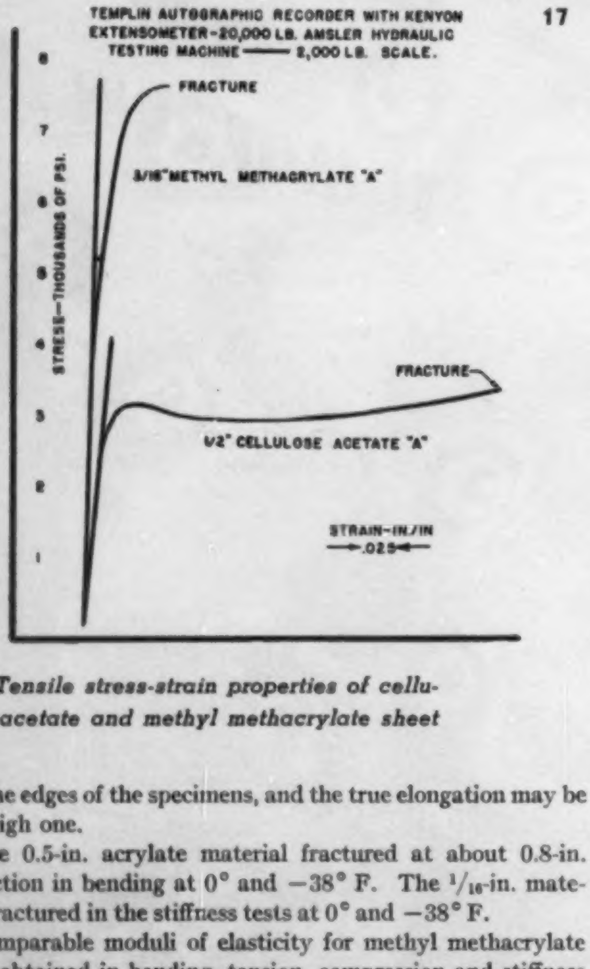
TABLE VII.—FATIGUE STRENGTH IN REVERSED BENDING OF PLASTICS AND WOOD

Data sheet No.	*Thickness of sheet, in.*	*Material*	*Direction of load*[a]	*Fatigue limit rotating beam, p.s.i.*		*Specific gravity*	*Ratio of fatigue strength to sp. gr.*		*Temperature at test, ° F.*
				Un-notched	*60° V-notch*		*Un-notched*	*60° V-notch*	
1	1/2	Methyl methacrylate	...	2,000[b]	2600	1.18	1690	2200	75 to 85
1	1/2	Methyl methacrylate	...	3,400[b]	....	1.18	2880	....	30 to 35
1	1/2	Methyl methacrylate	...	4,800[b]	....	1.18	4060	....	0 to −2
1	1/2	Methyl methacrylate	...	4,800[b]	....	1.18	4060	....	−30 to −32
2	1/2	Cellulose acetate	...	1,000[c]	....	1.30	760	....	75 to 85
3	1/2	Laminated phenolic "B," Grade L	L	5,000[c]	3500[c]	1.34	3730	2610	75 to 85
3	1/2	Laminated phenolic "B," Grade L	L	6,600[c]	....	1.34	4920	....	−30 to −35
3	1/2	Laminated phenolic "B," Grade L	T	4,000[c]	3000[c]	1.34	2980	2230	75 to 85
4	1/2	Laminated phenolic "B," Grade C	L	4,700[c]	3000[c]	1.34	3500	2230	75 to 85
4	1/2	Laminated phenolic "B," Grade C	T	3,500[c]	3500[c]	1.34	2610	2610	75 to 85
5	1/2	Laminated phenolic "B," Grade XX	L	5,200[c]	4000[c]	1.34	3880	2980	75 to 85
5	1/2	Laminated phenolic "B," Grade XX	T	5,200[c]	3700[c]	1.34	3880	2780	75 to 85
6	1/2	Cast phenolic	..	4,200[c]	2000[c]	1.36	3080	1470	75 to 85
		PHENOLIC-RESIN-IMPREGNATED, COMPRESSED, LAMINATED WOOD, MAPLE							
7	0.59	Panel A, low-resin content[e]	L	8,500[d]	7500[d]	1.29	6580	5810	75 to 85
8	0.63	Panel D, high-resin content[e]	L	7,500[d]	7000[d]	1.37	5470	5110	75 to 85
9	0.54	Panel E, resin-paper bond	L	9,500[d]	3000[d]	1.38	6880	5800	75 to 85
10	1.1	Panel C, non-compressed, resin-paper bond	L	4,000[d]	3000[d]	0.68	5880	4410	75 to 85
11	1.0	Wood, hard maple[f]	L	4,000[c]	....	0.70	5710	....	75 to 85
12	1.0	Wood, yellow birch[f]	L	6,000[c]	....	0.69	8690	....	75 to 85
13	0.65	Laminated, wood, birch, impregnated and compressed	L	11,000[c]	....	1.20	9160	....	75 to 85

[a] L = Specimens cut parallel to the length of sheet or parallel to grain of wood; T = Specimens cut transversely to the length of sheet.
[b] Fatigue limit based on 10,000,000 cycles of stress.
[c] Fatigue limit based on 100,000,000 cycles of stress.
[d] Fatigue limit based on 200,000,000 cycles of stress.
[e] Compressed 50 percent.
[f] Natural solid material; no impregnating or bonding used.

tion with decreasing temperature, Fig. 6. The cellulose acetate butyrate retains a higher elongation at −38° F., however, than any other material.

Methyl methacrylate—Methyl methacrylate plastic in tension at room temperature showed increase in load to a maximum and then a decrease as elongation to failure occurred, Fig. 17. Most of the specimens elongated 3 to 10 percent, averaging 6 percent, at room temperature. However three acrylate "A" specimens stretched 28, 45 and 50 percent and one "B" specimen elongated 30 percent at room temperature. All specimens were cut from the same sheet, side by side. The two that elongated 45 and 50 percent were located adjacently, and the one that stretched 28 percent was between two that had 9 percent elongation. The ultimate strengths in all specimens were comparable and did not vary with elongation. Approximately 50 acrylate specimens were tested at room temperature and only the four mentioned elongated extraordinarily, so the latter were not averaged in obtaining the average elongation. An elongation of 5 to 15 percent is given in reference 5 for methyl methacrylate. The lower values which are consistently obtained may be due to minute defects in the material or to effects of machining the edges of the specimens, and the true elongation may be the high one.



17—*Tensile stress-strain properties of cellulose acetate and methyl methacrylate sheet*

The 0.5-in. acrylate material fractured at about 0.8-in. deflection in bending at 0° and −38° F. The 1/16-in. material fractured in the stiffness tests at 0° and −38° F.

Comparable moduli of elasticity for methyl methacrylate were obtained in bending, tension, compression and stiffness tests.

Polystyrene—Greater variation in tensile strength at a given temperature was obtained for this material than for any other. It is brittle and the elongation is only about 1 percent, even at room temperature. The yield strengths at 0.2 percent offset were not obtainable; however, yield strengths at 0.1 percent offset are given in Table II. At room temperature even this is not obtained and it is given as the same as the average ultimate tensile strength.

TABLE VIII.—IZOD IMPACT PROPERTIES OF PLASTICS
0.5-in. sheet, 5 specimens tested for each condition

Temperature, ° F.	*Location of notch*	*Izod impact strength, ft.-lb. per in. of notch* Range	Average
		VINYL CHLORIDE ACETATE COPOLYMER "A"	
77	Edge	0.52–0.53	0.52
−38	Edge	0.42–0.47	0.44
		CELLULOSE ACETATE "A"	
77	Face	1.1 –1.6	1.4
−38	Face	0.17–0.22	0.19
		POLYSTYRENE	
77	Edge	0.19–0.24	0.22
−38	Edge	0.16–0.22	0.19
		METHYL METHACRYLATE "A"	
77	Face	0.37–0.50	0.45
−38	Face	0.28–0.43	0.37
		CAST PHENOLIC	
77	Edge	0.55–0.60	0.57
−38	Edge	0.50–0.53	0.51
		LAMINATED PHENOLIC "B," GRADE L, LONGITUDINAL	
77	Face	3.8–4.8	4.4
−38	Face	2.7–3.3	3.1
77	Edge	2.2	2.2
		LAMINATED PHENOLIC "B," GRADE L, TRANSVERSE	
77	Face	3.6–4.0	3.8
77	Edge	1.5	1.5
		LAMINATED PHENOLIC "B," GRADE C, TRANSVERSE	
77	Face	2.7–3.2	2.9
−38	Face	1.8–1.9	1.9
77	Edge	1.4–1.5	1.5
		LAMINATED PHENOLIC "B," GRADE C, LONGITUDINAL	
77	Face	2.5–2.8	2.7
77	Edge	1.8–2.0	1.9
		LAMINATED PHENOLIC "B," GRADE XX, LONGITUDINAL	
77	Face	1.9 –2.5	2.3
−38	Face	1.7 –1.9	1.8
77	Edge	0.55–0.60	0.57
		LAMINATED PHENOLIC "B," GRADE XX, TRANSVERSE	
77	Face	1.9 –2.1	2.0
77	Edge	0.55–0.58	0.56

Phenol-formaldehyde—The ultimate tensile strengths of the cast phenolic, non-reinforced, and the laminated paper- and fabric-base phenolic materials did not increase markedly with temperature decrease. There is little or no increase or a slight decrease, from 0° to −38° F. The elastic properties are increased, however, and the elongation decreased. The yield strength at 0.2 percent offset was not obtainable on Grade XX material, longitudinal and transverse, at −38° F., so the yield stress at 0.10 percent offset is given in Table II. Similar effects of temperature were noted in the stiffness and bend tests also.

Plywood—The tensile strengths of the plywoods were higher at 0° and −38° F. than at 78° F., but were slightly lower at −38° F. than at 0° F. The 3/32-in. polyvinyl-butyral-bonded mahogany-mahogany plywood and the 3/32-in. phenolic-bonded mahogany-poplar plywood developed about the same tensile strength. Tensile specimens taken from several

Table IX.—Miscellaneous Properties of Plastics[a]

Material	*Thickness*	*Parallel light transmission*	*Rate of burning*	*Water absorption, 24 hr.*	*After 6 months' exposure in Florida*	
					Parallel light transmission	*Appearance*
	in.	%	*in./min.*	%	%	
Vinyl chloride acetate copolymer "A"	1/8	81	Self extinguishing	0.1	78[b]	Flexibility and warpage O.K.
Vinyl chloride acetate copolymer "B"	0.04	88	Self extinguishing	0.1	87[b]	Flexibility and warpage O.K.
Polyvinyl acetal	0.02	85	4.0	3.1	44	Very poor, excessive shrinkage, cracks, warpage, brittleness, loss of clarity
Cellulose acetate "A"	1/16	86	Self extinguishing	2.0	81	Slight warpage
Cellulose acetate butyrate	1/16	87	Self extinguishing	1.2	82	Slight haze
Methyl methacrylate	1/8	91	1.1	0.3	91	No warpage, clear, very slight crazing
Polystyrene "A"	1/16	..	...	0.03	...	...
Cast phenolic "B"	5/16	..	...	0.03	...	...
Laminated phenolic "B"						
Grade L	1/8	..	...	0.8	...	...
Grade C	1/8	..	...	1.9	...	...
Grade XX	1/8	..	...	1.3	...	...

[a] Test procedures according to Air Corps Specification No. 12025-B.
[b] Four months' outdoor exposure.

panels of the phenolic-bonded plywood showed some variation in tensile strength, Table II. Elongation on all wood specimens was practically nil and unaffected by temperature.

Compressed impregnated laminated wood—Bending tests only were made on this material on specimens of approximately 0.25-in. thickness cut from the thicker panels. This material and also the non-compressed laminated wood were not markedly affected by decreasing temperature although some increase in strength properties was observed.

References

1 MacBride, H. L., "The Stiffness or Flexure Test," A.S.T.M. Proceedings, Vol. 37, 1937.

2 Aitchison, C. S., and Tuckerman, L. B., "The 'Pack' Method for Compressive Tests on Thin Specimens of Material Used in Thin-Wall Structures," Report No. 649, N.A.C.A., 1939.

3 Houwink, R., "Elasticity, Plasticity, and Structure of Matter," Cambridge University Press, 1937.

4 Gloor, W. E., "Plastics from Cellulose Acetate of Higher Acetylation," Modern Plastics *17*, 62ff (April 1940).

5 Plastics Catalog, Plastics Catalogue Corp., New York.

6 Kuech, W., "New Research on the Use of Hardening Plastics for Aircraft Construction," Journal of the Royal Aeronautical Society, January 1940.

7 De Bruyne, N. A., "Plastic Materials for Aircraft Construction," Journal of the Royal Aeronautical Society, July 1937.

8 Bartoe, W. F., "Service-Temperature Flow Characteristics of Thermoplastics," Mechanical Engineering, December 1939.

9 Delmonte, J., "Permanence of the Physical Properties of Plastics," Transactions of the A.S.M.E., August 1940.

10 Thum, A., and Jacobi, H. R., "Mechanical Strength of Phenol-Formaldehyde Synthetic Materials," V.D.I. Forschungsheft, Vol. 10, No. 396, May-June, 1939.

11 Nitsche, R., and Salewski, E., "Influence of Temperature on Strength of Plastics," Kunststoffe, August 1939.

12 Penning, C. H., and Meyer, L. W. A., "Cold Flow of Thermoplastic Materials," Modern Plastics *17*, 90 ff. (Nov. 1939).

13 Fishbein, Meyer, "Physical Properties of Synthetic Resin Materials," Technical Note No. 694, N.A.C.A., March 1939.

14 Riechers, K., "Synthetic Resins in Aircraft Construction," Technical Memorandum No. 841, N.A.C.A., November 1937.

15 Lloyd, R. M., "Compressed Impregnated Timber," *The Aeroplane*, December 13, 1940.

16 Axilrod, B. M., and Kline, G. M., "A Study of Transparent Plastics for Use on Aircraft," N A.C.A., May 1937.

17 Axilrod, B. M., and Kline, G. M., "Resistance of Transparent Plastics to Impact," N.A.C.A. Technical Note No. 718, July 1939.

18 Kuch, W., "Effect of Pressing Conditions and Composition on the Properties of Laminated Synthetic Resin Pressed Plastics," *Zeitschrift des Vereines Deutscher Ingenieure*, December 1939.

19 Federal Specification L-P-406, Plastics, Organic; General Specifications (Methods of Test), Government Printing Office, Washington, D. C.

Wolverine Gliders

(***Continued from page 66***) which prior to the war was known as the nation's largest manufacturer of public seating and as such had wide experience in handling molded plywood. This company since early 1942 has been operating under a sub-contract with Beech Aircraft Corp. to supply plywood parts for trainer planes.

Also working independently is Berkey & Gay Furniture Co., which turns out plywood parts for trainer planes manufactured by the North American Aviation Corp. at Inglewood, California.

Facilitating all of this Grand Rapids wood-aircraft work is an old $100,000 dry kiln, largest in the Midwest, which was completed by the Government shortly before the end of the last war for curing airplane spruce. Largely a white elephant since then, the kiln is now owned by the John Widdicomb company and is at last working at capacity at the job for which it was built 25 years ago.

Grand Rapids has undergone a terrific wrench in the transition from peacetime to war production, and it still remains one of the few industrial cities of the country in which there is a surplus of unemployed manpower.

But Grand Rapids technical men express confidence that the tremendous strength of the new plastic-bonded and hot molded plywood will win it a permanent place in all future aircraft work, regardless of the abundance of metals, and that the city thus has won a new industry which in peacetime, with the return to normal furniture manufacture, will bring it a lasting boom.

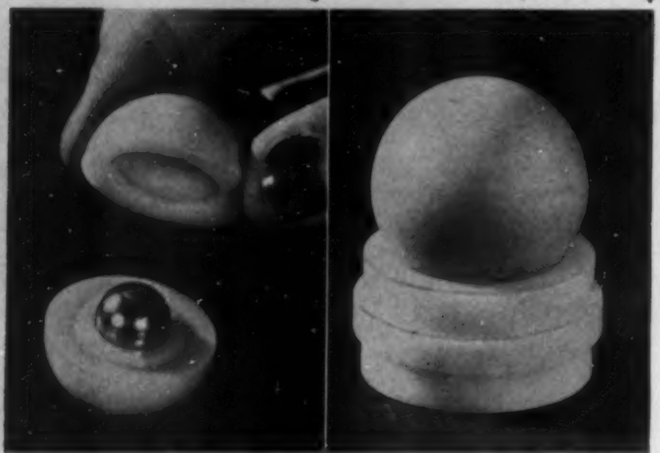
It is expected that plywood, and laminated wood spar construction, through savings in time and cost, will be a natural for the low-cost "family" airplane which will come after the war. Meanwhile, the work done during the war years by this Michigan group of glider builders will further advance the argument for plastic-plywood aircraft.

Valves for oil well pumps

(*Continued from page 83*) problem, John Fleming, an oil producer in the Pennsylvania fields, decided that plastics might be the answer to these corrosion problems, and sample molds were made for the manufacture both of the seat and of the ball. Cellulose acetate butyrate was the material selected. The seat problem was not too difficult, but the ball presented such difficulties that it has taken over two years to straighten them out.

As seen in Fig. 1, the ball was molded in two halves and

3 4



3—Method by which the steel ball is firmly inserted into the molded halves of the ball. The two halves are assembled with acetone and placed in a jig under pressure to get a tight bond. 4—Assembled plastic ball and seat

in such a manner that a spherical space was left in the center for the purpose of assembling a steel ball to increase the specific gravity of the unit. The original mold for the ball halves was gated at the parting line, but it was found that trapped air opposite the gate did not permit the piece to fill out and become a homogeneous structure. These molds were immediately discarded and new molds were constructed so that the gate was in the center of the depression of each ball half. The method of gating used in this mold permitted the material to flow uniformly throughout the piece. The gates were then carefully machined from the central hole, the steel ball inserted and the two halves welded together by the use of acetone and a jig, which exerted pressure on the two halves until they were securely welded together. The parts were then put into a ball grinding machine and ground to a perfect spherical contour. This job is being done in such a careful manner that the line along which the two halves meet is hardly visible to the human eye.

Some difficulty was encountered in the field when the seat was assembled into the working barrel. As shown in Fig. 2, the shoulder of this seat rests on a shoulder in the working barrel and an open cage with a similar shoulder is screwed down so that it comes in contact with the upper shoulder of this seat. This open wire cage serves not only to hold the seat in position on the working barrel but also to imprison the ball. Inexperienced operators, when first assembling these seats, screwed the cage down against the shoulder of the seat so tightly that they practically sheared the shoulder away. In order to eliminate this difficulty, a round steel insert was used in place of the plastic shoulder. This innovation is now considered unnecessary, as the operators in the field have been educated to the proper assembly of the new plastic parts.

In developing this plastic valve, the conditions of each well had to be considered. For instance, in Oklahoma, where the wells are from 3000 to 5000 ft. deep, the oil flows into the wells at fairly high temperatures. It was found that the plastic ball and seat could not be used in wells having a depth over approximately 1800 ft., because experience demonstrated that the valve and seat do not stand up when the oil temperature is greater than approximately 110° F.

This is an outstanding engineering development in plastics. It is one of the few so-called "conversion jobs" that has been undertaken not for the purpose of replacing metal but for that of doing a better job than metal has been capable of doing. As many of these balls and seats have been in continuous operation for 12 months, a great deal of labor and expense has been saved in the "pulling" of wells. The cellulose acetate butyrate, because of its dielectric properties, continuously resists the electrolytic action which had previously destroyed the metallic balls and seats. The plastic is light (weight of the butyrate ball and seat is 1/6 that of the metal valve) and in large-scale production will sell for less than the metallic parts. Patents have been applied for. The two parts are universal in that the plastic ball can be used with a metal seat or vice versa. Valves are molded to fit a standard 1 3/4-in. working barrel.

While it is true that at the present time this plastic valve and seat is particularly efficient only in shallow wells, it is also a known fact that within a short time plastic materials will have advanced to such an extent that these parts will be able to function perfectly at the higher temperatures and pressures which are encountered in the deep wells of Texas.

Credits—Material: Tenite II. Fleming Plastic Oil Well Valve molded by Plastics Div., National Organ Supply Co., for Baldwin Laboratories.

Labels for Leathernecks

(*Continued from page 58*) operates on a total cycle of 60 sec., making use of 600 p. s. i. injection pressure.

The larger size was originally planned for use on the round crown of the tropical helmet but in actual practice it has been found adaptable for the garrison cap as well. Because of the initial requirement, it was necessary that the helmet emblem be designed with a curved back which would fit snugly against the helmet's crown.

Therefore in making the tools for this piece, the big problem was hobbing. The engraver had to cut his design on a curve, which made a very difficult engraving task. In addition to the various planes and curvatures which had to be considered, the fineness of detail arising from the design of the emblem itself further complicated the engraving. Thus, drawing on the industry's experience in reproducing miniature pieces with a multitude of fine detail, it was decided to make a master die in a piece of tool steel, and in the die was done much of the engraving necessary to produce the entire design. The tool steel die was then hardened and a hob raised from this die by means of alternate hobbing and engraving. This became the working hob from which the mold cavities were hobbed in the normal manner.

A 4-cavity mold was constructed and put in production, operating on a total cycle of approximately 35 sec. and making use of 500 p. s. i. injection pressure. Total weight of the shot including sprues and runners is about 75 grams.

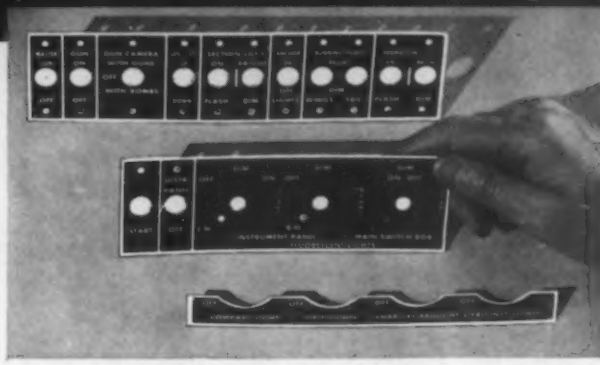
For both sizes, inserts which form the fastening screws

Look at all 4 types of

GRAPHIC LAMICOID

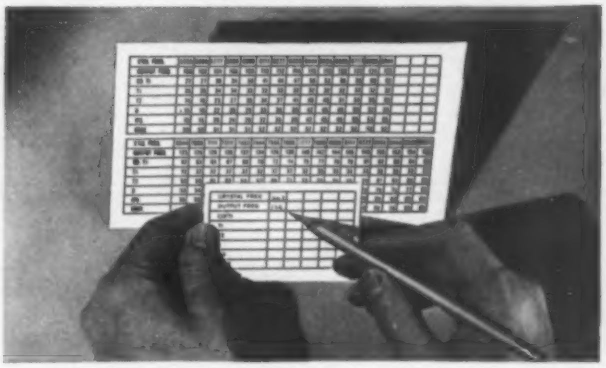
when specifying or designing equipment panels

1 STANDARD—Printing, lettering, calibrations and designs are permanently bonded under the surface of this plastic resin sheet which has characteristics common to all four types: — Rich, permanent finish withstands moisture and handling: Tough and light in weight, yet readily drilled and machined.



2 FLUORESCENT—Sharp reproduction of fine detail is obtained with any of the fluorescent materials. They become an integral part of the sheet — not just a surface coat — and thus cannot chip or rub off during installation or in service.

3 FLEXIBLE—This semi-rigid sheet material is suitable for instruction or identification panels which must be attached to curved surfaces of equipment — or where serial numbers or other markings must be cold-stamped on the finished material.



4 GRAPHIC FINISH 2-D—This material was specially developed for panels containing charts, operating information and tabular data on which computations or temporary records must be made. The surface permits extremely legible writing in pencil or ink and repeated erasures without wear on the material.

IT'S EASY to see why thousands of designers have switched to Graphic Lamicoid for instruction and identification panels. They get an economical method for obtaining quantity production of identical panels . . . a choice of four materials that assures the right characteristics and finish for each job . . . clean-cut lettering and legibility even in the smaller sizes . . . and a lustrous plastic resin finish that prevents fading or obliteration.

See how the four types summarized and illustrated above are serving war contractors today. Then investigate how Graphic Lamicoid will meet your requirements — by sending samples or blueprints of the panels you need. We will quote prices on any quantity promptly, without obligation.

MICA INSULATOR CO., Dept. 91, 200 Varick St., New York, N. Y.

We are sending samples or blueprints of our________

Quote prices on quantities of________

This is NOT an order.

*Name*________

*Company*________ *Title*________

*Address*________

USE THE COUPON TODAY

are put into a loading jig and placed in the mold, so that when the sprue is removed (Fig. 2) emblems are complete with threaded metal shanks molded-in.

Very little finishing is required beyond the removal of the gate. The mold is kept carefully adjusted to eliminate fins and "filling-in" around the anchor. In order to approximate the bronze finish of the metal piece, the mold cavities were sand blasted to eliminate the glossy finish usually achieved with plastics. However, the color runs all through the emblems, which won't fade nor rust and require no polishing as did the metal emblems—a boon to busy marines with little leisure or inclination for that extra shining job.

A further production economy was the elimination of an extra part and consequent speed of assembly. When the larger emblem was made of metal it required a metal nut and washer to hold it in place on hat or uniform. For the larger emblem, this nut and washer were redesigned to be molded in one unit and are produced 16 per shot from the same plastic material. All that is needed to fasten the smaller lapel emblem is a tiny round nut of metal. To speed assembly of these insignia for shipment, the molder developed a tiny revolving chuck in which the metal nut is dropped. As the nut spins, the operator starts the metal shank in the opening on the disk and it is thus automatically spun right onto the emblem in a few seconds (Fig. 4).

Although the prime reason for using plastics in this application was the replacement of metal, it developed that the new insignia were less expensive because of the mass production methods used, the reduction in the number of parts per unit, the speed of assembly, and the elimination of polishing operations because of the permanent color of the plastic. This time plastics have told it to the Marines!

Credits—Material: Tenite II. Molder: American Insulator Corp.

Molded tag holders

(Continued from page 67) making it entirely foolproof for plant protection purposes. In contrast to tags of metal the transparent thermoplastic tag offers a double viewing surface. The exposed side is that containing the war worker's photograph and numeral identification. When the tag is reversed, there are instantly visible other important data such as the worker's signature, signature of company officer, personal description and, in some instances, fingerprints.

In so far as war plant requirements were concerned, it was necessary to select a lightweight, non-breakable plastic material, and particularly one that would not burn. This last requirement is especially important because the holder is worn by welders, burners, etc., and flammable material would prove extremely hazardous.

Plastic license tag holders now supplied to hunters in California serve the same purpose. Instantly visible is the hunter's license number and personal description. Also inserted in the plastic holder is the duck hunting stamp which the hunter is required to purchase for the season, and this can be inspected by game wardens simply by turning the holder and without actually removing it from hat or other clothing to which it is pinned. The holder, being waterproof, is a decided convenience to hunters, who are not permitted to carry stamps in pockets or wallets. Freedom from rust is, incidentally, one reason why the plastic product has proved highly satisfactory.

The holders are molded in units of 16 per mold through use of a 32-cavity die. Attached to the sheet when it comes from the mold are 16 pin holders. These are small blocks made of the same thermoplastic material which are used to retain pins attached to the reverse sides of holders for attaching to clothes. The sheets, with pin holders detached, are delivered to the manufacturer's shop for mounting pins and detaching holders from the sprue. The operations are so simple and so few as to render the entire production job very economical from standpoints of speed and labor costs.

The main problem was to avoid the necessity of molding the case in two parts and then assembling them in one unit, cost of which would have been prohibitive. The mold was so constructed as to make multiple operations unnecessary. Provision was made for completely automatic withdrawal of side cores through the mold slots, this being accomplished by cams which are part of the die. In the 40-sec. mold cycle a clean product is obtained with only one operation remaining, that of mounting pins.

Each of the holders, or cases, in the mold unit has a locating boss in which to place the pin. In some the boss is horizontal with the case, in others perpendicular, depending on the manner in which it is to be worn by the individual. As soon as they are withdrawn from the mold, the small blocks for holding pins later to be attached are immediately detached from the sheets of 16 units before the latter are placed on plates for transfer to the shop of the manufacturing company.

The first step there is to inspect each sheet, after which it is placed in a wooden frame for handling during mounting of pins. The type of identification holder made for the Division of Fish and Game and for certain war industries measures $2^1/_8$ by $1^3/_8$ inches. The slot opening is approximately $^1/_{16}$ of an inch. The pin location projection centered horizontally on the reverse side is 1 in. long, $^3/_8$ in. wide, the block which fits over this projection being $^1/_{16}$ in. thick.

Next job is to place pins in the locating projections, which is quickly accomplished because the 16 identification card holders in the wooden frame are already lined up symmetrically. The retaining base of the pin is crimped, fits flat in the locating projection, so that once secured in place by the small plastic block it will not turn or twist, making it a highly durable clasp.

The frame is next passed to another operator for placing the blocks over pin holder projections. It is a one-two-three operation: picking up the small plastic block with the point of a phonograph needle attached to a penholder, immersing the block lightly in cement, then placing it on the projection to hold the pin. Then the sheet of 16 holders, now removed from the wooden frame, is placed in a kick press and in one operation removed from the sprue. The 16 holders fall into a container for wrapping and shipping.

If the holder is to be worn on a ribbon, as is now the custom in war production plants and Government agencies employing a great many feminine operatives, it is a simple matter to stamp an eyelet as an addition to the pin clasp.

The matter of sealing the slot after inserting identification card is something that is left for the user. It is claimed that various kinds of plastic glues are adaptable to the purpose, that they can be applied economically, quickly and with foolproof results. This, combined with low cost, light weight, durability, visibility and other advantages, has made the plastic more than a satisfactory replacement for metal.

Credits—Material: Tenite. Molded by Remler Co., Ltd., for Tri-Pak Gun Kit, Inc.

Expendable hypodermic

(*Continued from page 55*) oils, gasoline and water, and immune to the action of most corrosives, acids and alkalies. Its flexing life is 10 to 12 times that of rubber.

The plastic material is not subject to the oxidizing effects of air, sunlight and chemicals, resists temperature changes from freezing to 175° F., and will burn only in continuous contact with flame. Of uniform bore throughout its length, it forms a pressure-tight seal both with the glass ampule and with the collar of the hypodermic needle.

The syringe is so simple in operation that even self-injection by the wounded is possible. Thus where a gunner in a plane crew is injured by enemy fire, immediate injection to relieve pain may be administered with this unit. It may be used with equal facility and effectiveness by tank and submarine crews removed from normal medical stations. Filled with such emergency drugs as morphine sulphate, caffeine sodium benzoate, adrenalin, tetanus antitoxin and various types of sera, the unit is prepared for use in any emergency. Its widespread applicability to civilian defense and public health practices is also evident. During epidemics and similar emergency states, the device may prove a most practical aid for mass inoculation. In civilian life this unit also may be used effectively as in patients with asthma. Thousands of asthmatic sufferers now receiving frequent injections of adrenalin will have this convenient unit for immediate use.

Credits—Material for flexible tube: Tygon. Hypomatic developed by Schering Corp.

Wheatstone bridges

(*Continued from page 79*) resistor, and another serves as a combined insulating support for the main bridge terminal and protects the terminal opening from dust.

Figure 1 is a panel view of this radio frequency bridge with the cover removed. The hole in the panel between the two dials is covered from the back of the panel with a slab of the plastic material. The piece at the center is a pin jack mounted on this slab.

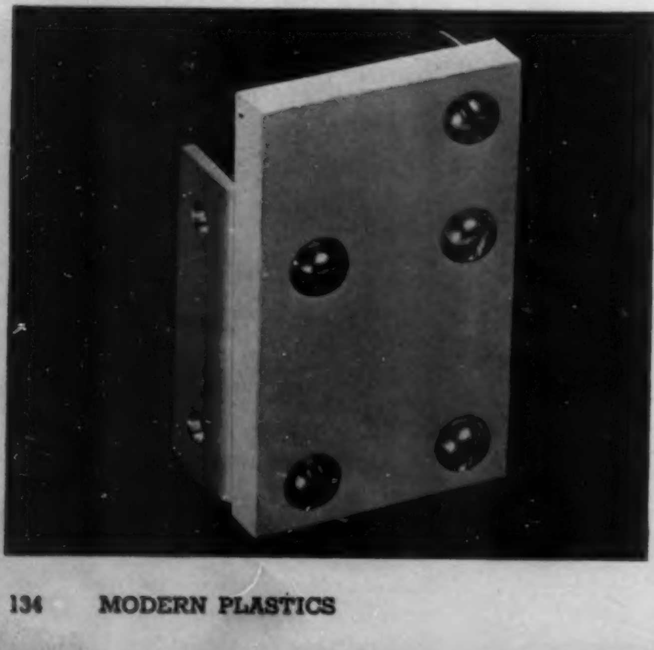
Figure 2 shows the interior of the compartment in which the triply shielded condenser is mounted. The third or cover shield is here removed so that the parts can be clearly seen. The two large blocks at the bottom support the outer shield and serve to insulate it electrically from the panel. Two similar blocks are, of course, under the other end of the shield. Between the outer shield and the middle shield are four other blocks, three of which can be seen in this photograph. On the next higher level are four more blocks which support the inner shield.

Figure 3 is a rear view of the unit with the outer shield removed. This view shows additional plastic parts, including the insulating body of the ultra-high-frequency standard resistor, which is shown in Fig. 4.

Credits—Material: Styramic. Fabricated by General Radio Co. for type 916-A radio frequency bridge.

4—The insulating body of the ultra-high-frequency standard resistor is machined from plastic material chosen for its exceptional dielectric and mechanical qualities

PHOTO, COURTESY GENERAL RADIO CO.



4

Labor standards

(*Continued from page 56*) tubes, blanks, or other basic shapes. It does include, however, the molding, laminating, machining or other fabrication of plastic parts and finished products, regardless of the place of manufacture.

In the past, industry committees have considered individual industries. Had that procedure been followed for this group of industries, 15 or 20 different committees would have been required with members traveling from various sections of the country to attend meetings in New York City. The economies inherent in the new procedure are plain.

Before acting upon the committee's recommendation, the Administrator will hold a public hearing at which any person affected by the proposed wage minimum will have an opportunity to speak.

An interesting by-product of this wage order procedure is frequently overlooked. In the course of their deliberation committee members gain a better understanding of the problems involved in setting up improved labor standards. This give and take is in the best democratic tradition—the tradition America is fighting to uphold.

The minimum wages under the Walsh-Healey Act are those which the Secretary of Labor has determined to be the prevailing minimum wage rates for specific industries in specific localities. Like the minima fixed by wage order under the Fair Labor Standards Act, these wage determinations are based on careful study of the relevant factors by an impartial board. So far, wage determinations have been made for nearly 60 industries with minimum rates of 30 to 70 cents an hour. One wage determination, effective April 28, 1942, will interest readers of this bulletin. It applies to chemical and related products and includes the following commodities:

A. 1) Heavy, industrial and fine chemicals including, among others, compressed and liquefied gases, and insecticides and fungicides, and

2) The by-products of the foregoing; and

B. Such commodities as: bluing; bone black, carbon black and lampblack; cleaning and polishing preparations (except paint and varnish remover, furniture and floor wax and polish, and soap); mucilage, paste and other adhesives.

Omitted from the scope of the definition of this industry are: ammunition, drugs and medicines, explosives, fertilizer, fireworks, paints, pigments, varnishes and lacquers, and

soap, which have been accorded separate treatment by the Secretary.

The minimum wages under this determination are:

1) Maryland, Virginia, North Carolina, South Carolina, Tennessee, Arkansas, Mississippi, Alabama, Georgia, Florida and the District of Columbia:
   40 cents an hour
2) All other States:
   50 cents an hour

In general this wage determination will apply to such plastic compounds as resins, casein, cellulose acetate flake, ethyl cellulose and cellulose nitrate supplied in mass form. This determination does not apply to finished products embodying plastic materials.

Basic straight-time hours of work under the Walsh-Healey Act are 8 in any one day or 40 in any one week. Overtime is permitted, of course, if time and one-half the basic rate is paid for all hours worked beyond the prescribed limits. For example, an employee whose total workweek consisted of four 10-hour days would be entitled to 8 hours at time and one-half under the Walsh-Healey Act. Under the Wage and Hour Law, which makes the workweek its standard, he would not be entitled to such overtime since his hours of work in that week did not exceed 40.

Where an employee worked, let us say, five 10-hour days and one 5-hour day during a week, he would be entitled to 15 hours at time and one-half under either law.[1]

Heretofore the Walsh-Healey Act generally prohibited the employment of boys under 16 and girls under 18 years of age. In order to facilitate the production of war materials, a recent exemption granted by the Secretary of Labor now permits the employment of girls between 16 and 18 years of age in any industry. These girls may not work more than 8 hours in any one day, nor between the hours of 10 P.M. and 6 A.M. And they are not to engage in dangerous or hazardous occupations.

The Walsh-Healey Act also requires that goods supplied on a Government contract be manufactured under safe and sanitary working conditions. Since this is the only Federal law which fixes such standards for manufacturing industries, these provisions are doubly significant now that conservation of man-power has become a prime necessity.

Here are the principal hazards which inspectors will look for: fire hazards; unguarded cutting machines and unguarded power transmission machinery; faulty ventilation and illumination; unsanitary shop, washroom and other facilities. A pamphlet issued by the Division of Public contracts entitled "Basic Safety and Health Requirements," discusses the safeguards that are required. In locations where State laws set up such standards, compliance with these regulations will be taken as prima facie evidence of compliance with these provisions of the Walsh-Healey Act.

Admittedly many firms are carrying out safety programs that are much in advance of these requirements, but others have not done so. In fact, a shocking number of employers do not take even the most rudimentary precautions. This neglect is indicated by the mounting toll of industrial accidents. During 1941 the Bureau of Labor Statistics estimates that such accidents caused nearly 20,000 deaths, more than 100,000 permanent impairments and over 2,000,000 temporary disabilities. The time lost exceeded 42,000,000 man-days.

(Please turn to next page)

[1] Employers who enter into certain collective bargaining agreements with their employees pursuant to provisions set forth in the Fair Labor Standards Act may employ them up to 12 hours a day or 56 hours a week without the payment of time and a half for overtime.

While not all of these accidents can be prevented, the shocking toll can and must be sharply reduced. A basic problem lies in the fact that many employers do not know how to initiate or put through adequate safety measures. Fortunately employers engaged on war contracts can now secure the help and advice of competent safety experts. Their services have been made available through the National Committee for Conservation of Manpower in War Industries. Created by the Secretary of Labor, the Committee's membership includes some 550 special agents, each of whom is a practical safety expert.

Employed by private enterprise, these agents serve the Committee voluntarily in strategic war production areas throughout the country. During 1942 these experts made at least one call on 10,775 production plants operating on direct Government contracts. The Committee also has regional representatives in eight key industrial areas. Employers who want further information may contact the regional representatives in their areas or write to the Division of Labor Standards, U. S. Dept. of Labor, Washington, D. C.[2]

Because the Wage and Hour Law and the Walsh-Healey Act both deal with labor standards, the agencies enforcing these statutes cooperated closely in the past. To further facilitate the work of administration and enforcement, the two agencies have been merged under an order of the Secretary of Labor. Now called the Wage and Hour and Public Contracts Divisions of the U. S. Department of Labor, the combined Divisions are directed by L. Metcalfe Walling, the present head of the Wage and Hour Division, who was also the first and only Administrator of the Public Contracts Division.

Except in the case of certain Defense Production Associations, the Walsh-Healey Act requires that every contractor be a manufacturer of or a regular dealer in the materials or supplies to be furnished under the Government contract. Where a dealer has a manufacturer deliver goods directly to the Federal Government, he will be considered an agent of the manufacturer and the latter's employees will be subject to the provisions of the Walsh-Healey Act while they are engaged in any operation necessary to fulfillment of a Government contract above $10,000.

In cases where a manufacturer buys materials or parts to be used in producing the commodity called for by his contract and it is a regular practice in his industry to purchase such supplies and not to manufacture them, the work performed by the vendor is not subject to the Act.

This does not mean, however, that a contractor may avoid compliance with the Act merely by shifting the work to a substitute manufacturer. In cases where the contractor turns over to another work which he would normally perform in his own plant, the contractor is liable for any violations of the Walsh-Healey Act which occur while the sub-contractor is preparing materials used to fulfill the Government contract.

Nothing in the Walsh-Healey Act prevents any person from meeting his Government contract out of stock on hand or manufactured before the contract was let. Thus it does not apply retroactively. The Act does apply, however, to employees who do further work on such material, either in processing or packing and shipping the goods *after* a contract is awarded. (*Please turn to next page*)

[2] The regional representatives are:
1. Lewis E. MacBrayne, 80 Federal St., Boston, Mass.
2. E. G. Quesnel, 350 Madison Ave., New York City
3. W. B. Weaver, Spray, N. C.
4. Carl L. Smith, 207 Republic Bldg., Cleveland, Ohio
5. John D. Petree, Alabama Department of Industrial Relations, Montgomery, Ala.
6. Harry Guilbert, Suite 1102, 220 S. State St., Chicago, Ill.
7. C. A. Miller, Texas Company Bldg., Houston, Tex.
8. R. E. Donovan, Standard Oil Bldg., San Francisco, Calif.

Contracts which exceed $10,000 come within the provisions of the Walsh-Healey Act irrespective of whether the material is delivered in installments or in one lot. Where a person bids on several items with an aggregate value above $10,000 but receives an award on only a few items totaling less than $10,000 his contract will not be subject to the Act.

Both the Wage and Hour Law and the Walsh-Healey Act contain certain exemptions and exceptions—provisions designed to give these laws added flexibility. Section 13(a) (1) of the Fair Labor Standards Act exempts from the minimum wage and overtime provisions any person employed in an "executive, administrative, professional or local retailing capacity, or in the capacity of outside salesman," as these terms are defined and delimited in Title 29, Chapter V, Code of Federal Regulations, Part 541.[3]

Without discussing all of the requirements for exemption in these categories, it may be said that executive employees must be paid a salary of at least $30 a week to qualify for exemption; for administrative and professional employees the salary test is $200 monthly, except in the case of lawyers and physicians, for whom there is no salary requirement. There is no salary test for outside salesmen. It should be emphasized that *in addition* to the salary requirements, the duties of these employees must coincide fully with the official definition given in the regulations.

In general, the Walsh-Healey Act does not apply to office and supervisory employees, to custodial employees or to certain maintenance workers. A foreman who does no manual work and has no direct physical contact with the goods furnished the Government will be exempt even if he occasionally lends a hand in the course of his purely supervisory duties.

This Act does apply to employees engaged in occupations connected with the manufacture, fabrication, testing, handling or shipping of goods furnished the Government in amounts above $10,000. Thus it will apply to laboratory technicians, draftsmen (except supervisory draftsmen), tool and die makers and other employees whose work is closely associated with the productive processes involved in the manufacture of products required by the Government.

The terms "custodial" and "maintenance" refer to employees whose duties are directed to the upkeep of the plant *and* who do no work on the commodities furnished the Government. Firemen engaged in producing heat and power for plant operation, telephone operators, janitors and watchmen usually would fall into this exempt category.

Both Acts also require covered employers to keep certain time and payroll records which must include the following information: employee's name, address, occupation (and age in the case of minors); time of day and day of the week on which employee's workweek begins; regular hourly rate of pay; hours worked each workday and total hours worked each workweek; total deductions from or additions to employee's pay; total daily or weekly straight-time earnings; total weekly overtime excess earnings—that is, the amount paid solely as overtime, above all straight-time earnings; total wages paid each pay period and the pay period covered by each payment.

Though education and voluntary compliance have featured the administration of these two laws, both Acts have "teeth" in them. Penalty provisions of the Wage and Hour Law include for willful violators a fine up to $10,000 and, in the case of a second offense, imprisonment up to six months, a fine or

[3] These regulations and other informative publications concerning the Walsh-Healey Act and Fair Labor Standards Act are available without cost at all offices of the Wage and Hour and Public Contracts Divisions, including the National Office, Desk MSS, 165 West 46th Street, New York, New York.

both. Disabilities that may result from failure to comply with the Walsh-Healey Act include cancellation of the contract and, where flagrant violation is found, employers can be blacklisted from Federal contracts for a period of three years.

"Enforcement policy has stressed the importance of securing compliance through voluntary action," Administrator Walling said recently, "and that policy will be continued wherever employers are cooperative. Nowadays all of us, management, labor and Government, are pretty well agreed that improved labor standards point the way to improved production. Industrial progress is a matter of men and machines and the plastics industry is a good example of the fact that progress is swiftest where payrolls and profits keep step.

"With millions of employees who are new to industry joining the production front, good labor standards take on especial importance," Mr. Walling added. "Training programs work better under such conditions, foremen and supervisors find their tasks less difficult and production totals climb faster."

This rather general discussion of the Wage and Hour Law and the Walsh-Healey Act does not pretend to answer all of the questions that individual employers may raise. Those who have special problems are urged to contact the nearest regional or field office of the newly merged Divisions which are strategically located from coast to coast.

The postwar rôle of plastics

(*Continued from page 59*) from lignin, bitumen, zein, Vinsol, and piccolyte resins, all very brittle materials—but need they be? At least if we cannot obtain properties suitable for textile products we might hold some hope for them as fibrous insulating materials.

Woods

The subject of wood and wood products warrants much more space than a few spoken words. If ever there was a material which the plastics industry should grow better acquainted with, it is wood, for it is quite likely that in developing structural applications we are going to depend much upon it. Such relationships between woods and plastics as that of woodflour fillers to plastics raw materials are not new to plastics technologists or wood technologists. Likewise we have some working knowledge of resin requirements in plywood manufacture. The next step, full resin impregnation of wood, has been suggested and proved. However, it has not enjoyed so wide an acceptance in the present war effort as we should like. Unfortunately, up to the present the increase in physical properties of wood through the impregnation with plastics has been attained only to the accompaniment of an appreciable increase in the weight or density of the wood—to the dissatisfaction of the weight-conscious aircraft engineers. Let me direct a pointed question to the plastics technicians present. "Need the combination of woods and plastics be accompanied by a density increase?" New wood and plastics developments in the near future will answer this question. I look for the day when we can call a plastic airplane "plastic" with a clear conscience, not because a mere 10 percent weight of plastic holds wood veneers together, but because material that is 40 to 50 percent plastic employs cellulosic fillers either in wood or pulp form.

Inorganic materials

Now that we have invaded the realm of cellulosic products, let us strike up an acquaintance with inorganic materials

such as clay, plaster, glass, cement and ceramics—which are plastic in a certain sense. Some of us have a knowledge of glass fibrous materials and the physical contributions these fibers have made to laminated phenolics. This is a noteworthy beginning. Let us give free rein to our thoughts for the moment and by examining possible combinations suggest further trends to be followed in the years to come. Whereas in the case of wood, the plastics engineer is seeking to augment the properties of wood with the more permanent qualities of plastics, in the case of inorganic materials, the clay, plaster, cement, etc., have been relegated to the somewhat dubious rôle of inert fillers. I expect to see in the postwar period the emergence of inorganic materials in a more prominent position than that of fillers in combination with plastics. The ceramics man may ask, "Why plastics?" We know the answers: colors, dimensional stability, lighter weight, design combinations, strengthening advantages, and the like.

Plastics and metals

In conjunction with and in combination with metals, plastics will assume a prominent place in postwar activities. I look for the day when every metal-working establishment will have a plastics division. There are many industrial designs whereby these two materials can be used in a complementary rather than in a competitive manner. Metal castings in molded plastics, resin-bonded metal fillers, metal-plated plastics and plastic-sealed metal castings—these are a few of the well-known combinations. Let us look further and we will find plastic adhesives for metal parts, wood and plastic laminates structurally reinforced with metal, and powder metallurgy borrowing the production techniques of plastics. I would recommend that plastics molders familiarize themselves with powder metallurgy, an industry to which they can make outstanding contributions.

Plastics and liquids

Having briefly surveyed plastics and solids—both organic and inorganic—I can now introduce liquids and fluids into the picture. Aside from plastics contributions to the closure field, let us with an eye toward the future look for more intimate contacts not necessarily based upon color and cost. For example, let us cite with pride the recent activities in resin-ion exchangers, which give promise of noteworthy developments in water and liquid purifiers. This field is still young, but certain of our plastics are proving their worth as liquid purifiers.

Of course, in speaking of plastics and liquids we can stretch a point and include liquid plastics, such as surface coatings, enamels and lacquers, which in the postwar period will be as prominent as in prewar days. We can, however, expect pronounced emphasis upon water emulsion paints and enamels, a boon to amateur housepainters because they may be thinned out with tap water. Noteworthy among the water emulsion paints are the "carbic" anhydrides which have opened up new possibilities in the surface-coating field.

Attempting to evaluate possible contributions of plastics to specific industries in the postwar era, we can only venture guesses at this time as to potential outlets, but we would be safe in examining aircraft and automotive fields, industrial designing, building materials and special laboratory uses. Our problem is all the more difficult because the postwar plastic materials may differ appreciably from the present outstanding types. We undoubtedly will hear much more about copolymers and interpolymers, as well as mixed esters, largely because present research efforts are directed towards finding new and more economic sources of raw materials. Further, plastics and synthetic rubbers are demonstrating

complementary qualities and there is every reason to hope for continuance of the combined efforts of the plastics and rubber industries after the war.

Aircraft and automotive fields

The war has made the engineering personnel of aircraft companies plastic minded, due largely to the strategic importance of aluminum. Resin-bonded plywoods and high strength paper laminates owe their present spotlight position to this situation. At the end of the war, plastics and resin-bonded laminates will have to compete with the large production capacities of aluminum, which will probably be cheaper than ever before. To simplify the problem, let us assume equivalence in strength-weight factors and materials costs. Aircraft and automotive manufacturers will base their decisions upon speed and ease of production, and the speed and simplicity of production of resin-bonded plywood structures have never been too obvious.

In other words, an aircraft or automotive manufacturer faced with the problem of tooling up for large-scale civilian requirements will tend to return to the medium he knows best—sheet metals—unless the plastics industry has developed techniques of forming large plastics sections with at least equivalent ease and speed. The first objection which the plastics industry may raise is the question of excessive metal tool and die cost. Yet even today one can ask with justification whether the die must be metal and whether the heating method need be steam. Tooling developments in plastics and high frequency heating methods still represent somewhat novel approaches to the problem.

Transparent, shock-resisting plastics will always be popular on aircraft. With more scratch-resistant types being developed, we may experience their more extensive utilization on automobiles—if not for all the transparent panels, at least for front windshields—with light polarizing panels to reduce the headlight glare from oncoming cars. In addition, emphasis will be placed on greater visibility and large, generously curved windshields will find an answer in transparent plastics.

Machine and product design

Plastics and industrial designers are well acquainted, and we can expect a decorative as well as a functional display of plastics in machine and product designs in the years following the war. Industrial designers will be appreciative not only of the more decorative and colorful plastics but also of the industrial materials which can claim only utility and economy. Developments in jet molding and transfer molding of thermosetting materials will extend the utility of this type of molding compound into new and more significant applications. Further, the field of low pressure laminating will also permit greater latitude of design. New production methods and new materials are all the tools the product and machine designer require. As large-scale applications are developed, we can expect some specializing in machinery and tools—for example, molding machines to produce only one type of article. In consequence there may appear more consumer molders who are prepared to supply a limited range of moldings or extrusions of their own special design.

On the other hand, the war is teaching the plastics industry that it cannot ignore the production requirements of even several hundred units and means must be found to turn these pieces out. One obvious method is mold standardization as far as possible, with replaceable mold construction elements such as inserts and the like. Small custom molders specializing in temporary molds and limited production may

be an outcome of this war. This means greater production facilities for translating into finished pieces the thoughts of machine and product designers.

Building materials

It is not unreasonable to expect plastics to make a strong bid for preeminence in the field of building materials in the years to come. They have made a noteworthy start already in the development of outdoor grades of plywood. However, one can expect a further expansion in the applications and forms of extruded channels, tubes, conduits, hardware, trimmings, decorative edges and many others. Postwar kitchens and bathrooms should be replete with extruded plastic accessories in various colors. Articles of furniture should reflect the wartime experiences of wood manufacturers and cabinet makers who today are much engrossed in the problems of resin adhesives. The recently developed wooden springs reflect the ingenuity of wood men in meeting the exigency of disappearing metal springs.

Throughout private homes, architects will feature the decorative aspects of newer plastics, perhaps in indirect lighting, perhaps in the replacement of brass hardware throughout the house, or perhaps as insulation in the wall spaces or roof. Plastics applied to or in combination with such commonplace materials as Celotex, wooden laths and veneers are to be expected. While we might find plywood or plastic bathtubs a consequence of war developments, it is unlikely that their replacement of metal is anything more than a temporary expediency. However, the valves, faucets, shower heads, fittings—these are here to stay in plastics.

Packaging

Semi-rigid transparent containers consumed a large volume of plastics before the war and will no doubt repeat this performance after the war. However, we can hopefully look forward to an even greater rôle for plastics in the packaging field. With air transport planes bringing remote corners of the world within a few days' travel from the United States, we are going to ship more goods than before and we are going to require more satisfactory containers for overseas service. Combinations of plastics with paper or wood may provide the best answer for the container problem.

Back on the home front we can expect a conversion of the output of certain types of plastics essential to the war program into peacetime channels, with important ones developed in the packaging field.

Scientific research

In many small but nevertheless valuable ways plastics are aiding specialized scientific researches. The character of these researches are of such far-reaching importance as to merit expanding applications after the war. For example, we find:

1. The mounting and preparation of samples for electron microscopes require transparent plastic films.

2. Stresses and strains in structures are now being studied with the aid of brittle plastic surface coatings or by polarized light used with transparent models. Not only will plastics be enjoying continued success in this field, but further techniques of stress analysis will be developed, such as the use of craze marks on acrylic materials. Extended activity in transparent models of industrial equipments is a certainty.

3. Polarized light, always a useful tool for scientific research, will enjoy many more applications due to the future availability of transparent plastics.

4. Electric voltage stresses in solid insulating will be

studied with the aid of transparent plastics. This should prove of fundamental importance to certain types of electrical equipment.

5. Numerous scientific instruments formerly housed in metals have been redesigned during the war period with plastics housings or at least units incorporating important plastic components. The trend toward plastics in the instrument field should continue strong.

In conclusion, we cannot display too unbridled an enthusiasm for plastics after the war, and in applying lessons learned during the war, we can be better prepared for meeting the new industrial requirements.

A new partnership is formed

(***Continued from page 54***) aluminum inserts. Threaded aluminum bolts imbedded in plastic parts are a good example of this technique. Aluminum and plastic fittings are appropriate where strength and lightness are required and attractive appearance is also a factor.

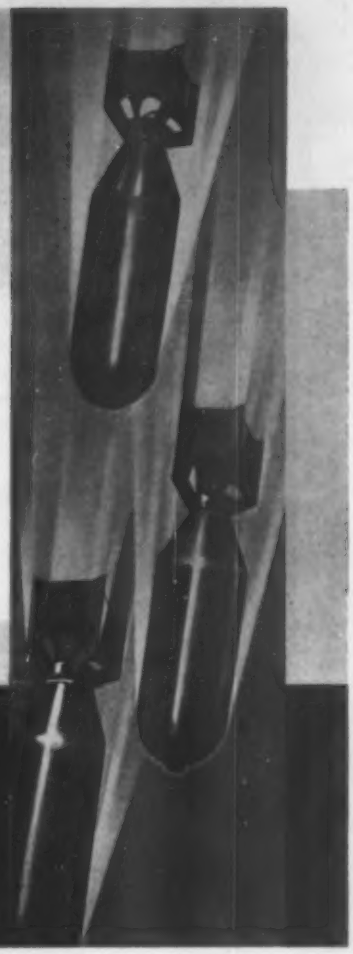
Aluminum itself has a natural pleasing silvery color, and variety has been added by changing texture and luster through scratch brushing, burnishing, etching and other mechanical means. Oxide coatings add surface hardness and distinctive appearance and can, in addition, be given a wide variety of hue and color. The use of aluminum and plastics together has broadened the horizon of the designing engineer, and has resulted in some interesting combinations. Plastic table tops have been made with insert designs of aluminum foil. Aluminum door plates for refrigerators have brightly colored plastic inserts, while cupboard door handles made of plastic have complementary strips of bright aluminum. When aluminum and plastics are again available for domestic use after the war, it will be interesting to see what industry will do with the colorful combinations found in these two materials.

Wrapping materials

The use of aluminum foil and sheet plastics firmly cemented together had become established before the war. While many of the uses for this material fell into the novelty class, one of great practical importance was its application to heat sealed food packages. At first the use of this material was confined chiefly to individual servings of foods or medicines, as typified in the package designed to carry individual Alka Seltzer tablets. However, when the handling of food in the present war began to constitute a major problem, this was one of the developments taken over by the Army. Ration packs now used by our armed forces utilize these heat sealed packets for powdered coffee (Fig. 4). These packets must withstand all manner of handling under the most difficult conditions, in temperatures ranging from sub-zero to the steaming tropics. The package consists of a small envelope made of aluminum foil, impervious to moisture, and coated with a sheet of plastic, which under pressure has been given an hermetic seal. So successful has this type of packet proved in service that other types of powdered and dehydrated food products will probably be packaged in this manner in the near future.

Wire and cable

Aluminum wire can be given a coating of a plastic having excellent insulating properties. By using the plastic in different colors, intricate code wiring can be followed easily. A somewhat similar example is seen in coaxial cable, one type of



which, used in short wave radio transmission, is made with an inner wire running through the center of an aluminum tube. Tiny plastic disks serve as insulators and also as spacers to keep the center wire equidistant from the outer walls of the tubular section.

Furniture and luggage

The combination of aluminum and plastics has also entered the furniture field. Some of the newer aluminum chairs brought out just before the war have plastic upholstery, while a new type of chair upholstered with woven extruded plastic has an aluminum frame. Another interesting idea which has recently been the subject of some experimental work is a type of airplane luggage fashioned of aluminum sheet and jacketed in a scuff-resisting coat of vinyl plastic.

The illustrations selected here are only a few of the many already found practical, and comprise a cross section of the work being accomplished in fitting aluminum and plastics to modern needs. It will be apparent, however, even from these few observations that the strength, light weight, and other desirable characteristics of aluminum can be supplemented by the judicious use of plastics, and that intelligent cooperation between these two materials may well prove the answer to many of tomorrow's problems of design.

Wind-up of the helmet

(*Continued from page 52*) lamps which dry the paint in about 3 minutes.

The helmets are weighed again to meet the $9^1/_2$ to 10-oz. weight specification and inspected for size so that they will fit snugly within the large outer steel helmets. The chin straps are added before the helmets are packaged in special containers.

Advantages of machine wrap preform technique

In comparing the wound preform with other methods of stock preparation and molding, it is estimated that there is a reduction in the use of materials, resin and fabric amounting to 15 to 20 percent. In addition to material savings, this process of preforming is said to produce a stronger helmet since the mold load so closely approximates the shape of the finished article. Other methods of stock preparation for mold loads could be improved upon, as there is a great possibility of crushing and breaking the duck fabric when nubs or folds of fabric, plus extra plies, must be compressed together between two metal surfaces during the molding operation. It can be realized that, using the special wound preform and air bag method, the fabric will not be crushed but simply compressed together to a uniform thickness, free from wrinkles, with a more even distribution of fabric and resin.

This should be of particular value when the helmet liner is subject to a steam bath in the delousing process which might tend to distort and change its shape.

Simplicity and speed of manufacturing operations plus economies in raw material and equipment make this method of machine wrapping of preforms ideal for the production of irregular shapes such as curves or globular forms. In the production of secondary aircraft parts, particularly, where comparatively small quantities of high-strength parts must be run quickly and at a low cost, this technique is highly adaptable. The method of wrapping allows exacting control with a small degree of variation of the total weight and strength of the preform or mold loads—an important factor where close tolerances and exacting specifications must be met.

(*Please turn to next page*)

This construction is eminently suited to postwar production of furniture, automobiles, refrigerators and numerous other pieces of unusual contours.

Credits—Material: Durez. Engineering: Hood Rubber Co., J. H. Flink, W. R. Hickler, F. A. MacDonald, F. Olson, in cooperation with Quartermaster Corps, Office of the Quartermaster General, Washington, D. C., and Quartermaster Depot, Chicago, Ill. Dies: Federal Engineering Co.

Handling thermoplastics

(*Continued from page 82*) when the softened material will again be free-flowing. It is necessary that the containers be air-tight, since ethyl cellulose tends to regain moisture fairly rapidly under warm, humid conditions. It has been found that the material as it cools does not coalesce as it does in the feed hopper throat, probably because there is no flowing motion to force one granule into the next. It is best to allow no more than an 18 in. depth of flake to be piled into the cooling box, in order to ensure rapid cooling and to prevent piling up of enough stock to create pressure which might coalesce the bottom layers. Wide-topped, 5-gallon cans holding about 25 lb. of material will be found convenient cooling containers for this dried flake. These cans may be tin or terne plate, lined or finished with an oleoresinous baking finish or similar insoluble coating in such cases as may require the elimination of possible iron contamination.

The softer formulations do not require such thorough drying as the harder ethyl cellulose injection formulas—those having a Rockwell M hardness of 30 or more. Hence if the volatile content runs as high as $^{8}/_{10}$ of 1 percent, perfect moldings can still be made.

Polyvinyl chloride is one of the few materials which absorbs practically no moisture, and under proper storage conditions will normally require no pre-drying whatsoever. If stored in a damp place, however, due to rapid chilling or exposure to extremely high humidities, moisture will condense on the surface and present the usual molding difficulties. If it becomes necessary to pre-dry this type of material, it is important that it be completely protected from all ferrous metals. The presence of contamination of this type will result in the thermo-decomposition of the material at molding temperatures. All drying trays, scoops, grinders, etc., with which this material may come in contact prior to molding must be completely free from rust.

While oven drying of thermoplastic materials is by far the most widely used method of removing moisture, some serious thought should be given to different types of equipment, some of which will perform more satisfactorily and at a lower overhead cost.

The rotating drum

One molder has made use of a long rotating drum, possibly 30 ft. in length and 4 to 5 ft. in diameter. The horizontal axis of this drum is set at a slight angle so that as the drum rotates the material travels from one end of the drum to the other, and at the same time is continuously agitated. A forced feed system of hot, dry air is used in conjunction with this drum. This molder passes the majority of his thermoplastic materials through this rotating drum dryer and stores them in sealed metal containers. It has been his experience that though its moisture content is reduced to about .2 to .3 percent by this process, the material nevertheless picks up enough moisture to be unusable after a very few days of

storage. This, of course, means that the material must be re-dried before using.

The moving belt

Figures 2 and 3 show another method of production drying, following which the material can be charged directly into the machine hopper or be stored for a short length of time in sealed metal containers. Beneath the hopper on this piece of equipment is located a chute, the angle of which may be changed in order to regulate the flow of material onto a moving belt. Assembled directly to the chute is an adjustable vibrator which also controls the speed with which the material travels from the hopper to the belt. With these two controls, the granular material can be laid on the moving belt in varying thicknesses. A variable speed mechanism controls the speed with which the belt travels. Suspended above the belt along its entire length is a bank of infrared lamps. The circuit of these lamps is wired to allow as many lamps to be turned on as are required for the particular material being run through the dryer. Equipped with these controls, such a machine can be adjusted to accommodate nearly any type of thermoplastic material with practically any amount of moisture present. The entire unit is completely protected by a dust enclosure which even includes the receiving drum at the end of the drying line. The feed hopper is large enough to accommodate an entire drum of material, and once loaded is also closed off with a dust-proof cover.

By employing a piece of equipment of this type many molders will be able to dry sufficient material to keep all the machines running at full capacity. In addition to protecting the material from contamination from dirt while being dried, it is a versatile piece of equipment in that it will handle almost any type of thermoplastic material no matter what its percentage (within reason) of moisture content.

There are, however, several problems inherent in this type of equipment, similar to those which are encountered in the use of a rotating drum type of dryer. Although the capacity of this infrared belt dryer is high, the molder is still faced with the problem of drying several colors and types of materials in the same machine and probably on the same day. Each change of material will, therefore, necessitate a complete cleaning of the machine. It will also necessitate temporary storage of dried materials which, if stored over a few days, must again be put in the dryer.

Vibrating inclined platforms

Much thought has been given to the design of a piece of drying equipment which will not only be universal, but which also will operate at such speeds and in such a manner that there will be no dried material storage problem. The construction of this piece of equipment must be fairly simple and the cost kept to a minimum, for it is necessary to equip each molding machine with one of these dryers.

Figure 4 gives the general layout which should be followed. The feed hopper should be of ample size to accommodate somewhat more than one full drum of material. The framework may be 2 by 4 ft., with the enclosure, hopper and inclined platforms constructed of plywood. Each bank of infrared lamps should be constructed as a unit and securely mounted to the framework of the enclosure. As shown in the sketch, adjustable electric vibrators are mounted beneath each platform. The lowest platform or "feed chute," which feeds directly to the hopper of the molding machine, should be adjustable as to angle.

The sketch shows a bank of switches wired in such a way

as to give several different light intensity combinations which can, of course, be varied in almost any manner the builder desires. As shown in the drawing, doors with glass panels should be constructed at each level to permit easy cleaning and to allow for complete inspection of the operation of the machine at all times. This inspection will be important at the beginning of each new job as several adjustments of each vibrator will be necessary in order to ensure a continuous and even flow of material.

No attempt has been made to fix any of the dimensions, inasmuch as the size of each dryer will be, of course, proportional to the capacity of the molding machine on which it is installed. The dryer's general shape will to a great extent depend upon the amount of headroom that is available. An overhead monorail system with some type of hoist should run along each line of equipment to simplify the loading of the feed hoppers. If convenient, the monorail system can travel the entire distance between the molding room and the place of material storage.

An attempt has been made in this article to offer suggestions for the handling and drying of materials. It is appreciated, of course, that many plants have already installed their own version of this type of equipment. It is also true, however, that there is always room for improvement, and some of the suggestions here given may be of assistance to molders who have had difficulties with thermoplastic materials.

Acknowledgments

Modern Plastics appreciates the assistance given in the preparation of this article by the following material suppliers: Dow Chemical Co., Hercules Powder Co., Tennessee Eastman Corp. and Celanese Celluloid Corp.

[G. M. Kuettel of the Plastics Dept., E. I. du Pont de Nemours & Co., Inc., has under preparation a complete factual analysis of the results obtained when materials with varying moisture content are molded. This article will appear in the Engineering Section of the May issue of Modern Plastics.—Ed.]

A British plan for furniture

(*Continued from page 72*) built-in units, so when we say "mobile furniture units," we mean chairs, tables and other light furniture. Basically all these furniture units consist of a combination of *rigid sheets* and *frames* (or rails). The sheet material used today is very different from the traditional solid wood panels, for as the gluing, veneer-cutting and laminating technique developed there was a steady improvement in the qualities of sheets used for table tops, panels, etc. It is interesting, however, that the *framework* used today shows no great development when compared with the mediaeval manner of using solid wood. Most of the furniture units are being supported by frames, shaped from straight pieces of solid wood, subsequently tenoned or joined together. Every joint means labor (whether made by hand or by machine) and these points are also ever-present sources of trouble. Attempts to create furniture units with fewer corners, joints and intersections are, however, as old as furniture making itself. It is possible to use solid wood cut into bent shapes and thus save certain points of intersection. This possibility is, however, not a very economic procedure, nor is this technically correct, as the moisture movements of the wood will differ in various parts of the frame according to the direction of the grain. (*Please turn to next page*)

Other possibilities of providing frames with fewer joints and intersections have been developed during the last 40 or 50 years. As plastics are directly or indirectly concerned with the future development of the types of processes used in the manufacture of such "bent" frame and furniture units, it may be of some interest to survey the possibilities (and limitations) of such developments.

Bent metal furniture. The use of tubular steel, aluminum alloys, strip metals, etc., has made it possible to produce continuous frames and to use one component instead of two, three or more parts by bending the metal to the required shape. This technical advantage makes the units more resilient, lighter in appearance, and the higher strength makes the metal furniture more elegant, in the technical sense. On the other hand, the surface-protective treatment of metals depends on a thin film which, however hard-wearing, does not always compare favorably with the wearing qualities of hardwood surfaces so far as domestic furniture is concerned.

Incidentally, the finishing of metal furniture, such as the anodized aluminum, is a promising field for plastics research.

Steam-bent wooden frames. The thermoplastic bending of wood, cane and similar originally straight elements can be regarded as the forerunner of modern construction of light furniture. It would be ideal if we could obtain the resilience of steel combined with the wearing qualities and pleasing touch of wood. The bent-wood furniture comes very near to the right solution, but not quite. The straight piece of wood, when it is bent to the required shape, has still something like a "plastic memory," and will try to regain its original straight shape whenever there is an opportunity for doing so. This is, as a rule, prevented easily by securing the bent shape to other parts of the furniture at several points, although the procedure causes a certain limitation of the design, and makes all the difference in the appearance and function of the furniture. This applies more or less to all frames which are being made by thermoplastic bending, whether the material is wood, cane or plastics. There are plenty of beautiful examples of this type, but it is more probable that bent wood will be used mainly for utilitarian purposes, while the task of bent cane is to provide gay and light garden furniture.

Frameless furniture. Up to a certain point it is possible to do away entirely with the frame structures by using rigid sheets throughout. Just as doors, table tops and similar articles have been produced by using solid sheets or blockboards, it is possible to make tables, armchairs, etc., which are supported by suitably shaped rigid blockboards or laminboards. As the core of the usual blockboard consists of a number of narrow laths, the manufacture of curved surfaces is not difficult. To produce firm and bent laminboards is also possible, and even narrower curves can be obtained, as the core of this type of sheet generally consists of a multitude of veneer strips, the width of which depends upon the thickness of the sheet (vertically laminated).

The use of every type of rigid sheet, whether wood, glass or plastics, can produce such frameless furniture units as a coffee table made of glass and polymethyl methacrylate. It will be realized, however, that the principle of doing away entirely with the frame construction is applicable only to certain types of furniture, and the field of its usefulness is confined within definite limits.

Laminated wood frames. The best and technically the cleanest methods of producing bent continuous frames have been so far achieved by various laminating techniques. The shapes are generally built-up from several layers of wooden

laminae, which become locked so that there is little or no tendency to straighten out.

This principle is entirely different from that described under "Steam-bent wooden frames," above, and the laminations are made, as a rule, on presses to form large, bent shapes from which frame elements of the desired widths can be sawed.

The principle of this type of construction is so sound that it may be worth while to investigate the possibilities of plastics in this connection in greater detail.

Resin-bonded chair frames

So far as the construction of continuous frames is concerned, we have seen in the preceding paragraphs that laminated wood is in many respects more satisfactory than solid wood or even metals. We have endless varieties of wood veneers, a large number of solid and liquid synthetic resins but we cannot make any decisions on these until we visualize the shape and nature of the finished articles we intend to produce. We have to decide upon the suitable design (or designs), the suitable types of wood laminae, the nature and quality of the plastic to be used and the details of the manufacturing process. The writer has designed, therefore, a fictitious example which will enable us to go into the details more fully.

The development study seen in Fig. 2 shows the essential three stages of the manufacture: first, the raw material stage; second, the half-finished stage (the manufacture of mass-produced laminated bodies); third, a number of sawed shapes or frames (C); and fourth, the finished stage which is represented here by a number of variations of chairs and armchairs. It can be seen that the principle is largely the same as in the previous suggestion (drawer parts, Fig. 1), that a few standardized, mass-produced components should result in a large number of varied finished components.

1. The prime stage—choice of suitable raw materials. It would lead us too far to enumerate the range of available wood veneers, characteristics and specifications of which are widely known. Although the choice of the suitable type of log peeled and sliced veneers and the quality of wood chosen is of great importance, let us concentrate on the details of the various synthetic resins and other interlayers which may be chosen to form part of the laminations.

The thermohardening resins which come to mind as adhesives or impregnators are available in such variety that all conceivable requirements of processing can be satisfied. But it is not always the best plan to require unusual modifications of the resins as such may not be possible without reducing the performance and ultimate quality of the resin.

Solid interlayers. Thermosetting plastics can be obtained in putty-like consistency or, what is more usual, in the form of flexible glue-films. The use of the latter obviates the difficulty of eliminating the surplus glue between the laminae and also ensures that the right amount of adhesive is being used throughout. We have a good range of thermohardening plastic films, many of which are being used on a large scale in the manufacture of plywood. These films are mostly thin layers of fibrous material (such as paper) impregnated with the resin, which is capable of flow and hardening under the influence of heat and pressure. Most of the brands are actually designed for the manufacture of plywood and are eminently suitable for high-temperature processes, and work on hydraulic presses.

It will be realized that the plastic interlayers will become exposed when the laminated shapes are sawed so that every

layer becomes visible as the sawed edge of a very thick plywood. This fact presents us with a number of practical difficulties and indicates that the wooden laminae should be perfectly impregnated, as well as stuck, to avoid undue moisture absorption by the untreated wood. We must also take into consideration the coloring of the resin layers, a factor which is of little or no importance in the manufacture of ordinary plywood. Such difficulties can be overcome, of course, when processor and chemical supplier cooperate.

The use of flexible thermoplastic interlayers would also offer certain advantages. So far, mainly on account of the costs, the choice of thermoplastic resins for such purposes is limited.

Solid interlayers other than wood and the plastics mentioned above would probably be impracticable for the manufacture of chair components with the exception of fabrics. These may be incorporated either to modify the performance of the structure or to provide a close-mesh fabric surface or to act as a carrying agent for liquid glues. Thermohardening resins are capable not only of adhering to fibrous material but of locking the fibers of fabrics perfectly, a fact which holds for almost the whole range of available fabrics.

For some specific uses, the incorporation of a number of metal sheets may be desired, but this should be carried out later, preferably at the finishing stage. Sheet material, consisting of wood veneer and steel, could then be applied to the surfaces.

Plastics of paste or liquid consistency. The choice of plastic resins in dissolved or emulsified form is sufficiently large to meet all working conditions. In the case of thermohardening resins it has been found, however, that it is sometimes necessary to provide the solvent and solid resins separately, thus facilitating transport and storage. And for air-drying solutions some mixing on the spot is inevitable.

The chief difference between the thermohardening resins and the earlier types of glue is not always clearly understood. It is not the evaporation of the solvents which brings the synthetic resin glue to set, but the chemical action which takes place at a certain predetermined temperature. With the use of modern modifying agents, this temperature may vary from ordinary workshop-temperature up to 300° F.

Phenolics and ureas can be used at workshop temperature, but these resins must be as a rule mixed with accelerators (organic acids) just before use. Certain urea resins are extremely easy to use as the mere addition of water is required for mixing. One variety can be prepared from crystals, with water added, to form an air-drying glue.

Water-soluble urea resins are capable of plasticizing wood to render it malleable for bending and shaping. There are, however, two schools of thought as to the efficiency of this treatment compared with steam and boiling water.

In tests carried out by the Forest Products Research Laboratory[1] (Princes Risborough, Great Britain), it has been found that the initial moisture content of the laminations (before gluing) has an important effect on the dimensional stability of the laminated bent shapes. It is recommended that "whenever possible . . . the laminations should have a low moisture content and be of maximum thickness so that the number of glue layers is kept to a minimum." The difficulty is, however, that in order to be able to carry out shaping processes before the lamination, we have to treat the laminae with steam, boiling water or, as suggested by the Forest Products Laboratory (Madison, Wis., U. S. A.) by prolonged soaking in a urea solution.[3] Unfortunately these treatments seem to increase the hygroscopicity of the wood, thus raising the initial moisture content. (*Please turn to next page*)

Another interesting point in using a certain type of urea resin is the possibility of spreading it on the veneer surface while its hardener (accelerator) is spread on the opposite surface of the next layer. The difficulties of mixing would, therefore, be entirely avoided.

Most of the thermosetting resins are suitable only for processes at higher temperatures without accelerators, and these could be used for the production of laminations such as our example if facilities for hot pressing, autoclaving, etc., are available. It may be of advantage to use very thin layers of expensive wood veneers as the covering layer of the laminated body. This consideration would certainly suggest the use of one of the special types of glue which have been developed for bonding thin veneers. The use of these glues, such as the foamed urea resin type, is also very economical.[4]

While there is an amazing choice of thermosetting glues, the range of the suitable thermoplastics is, so far, very small. As time goes on, research which is being promoted on the use of vinyl resins will make it possible to produce more pliable and resilient laminations. The practical difficulties involved in the economical use of polymerized resins will probably be overcome.

There is no controversy as regards the improvements which thermohardening resins have brought about in the manufacture of plywood structures when compared with the results obtained by older types of animal and casein glues.

2. *The half-finished stage—manufacture of the laminated shapes.* The choice of the suitable resin depends to a large extent upon the circumstances under which the laminating process is to be carried out to produce the half-finished shapes. Instead of developing some new methods to suit the particular characteristics of a given resin, the development so far has been promoted mostly in the opposite direction by trying to select a suitable resin for the existing manufacturing facilities. No doubt both types of development are equally important.

To build up the laminated shapes suggested in our example (Fig. 2) the process presents three basic problems, whatever the adhesive used. It is possible to combine two or more of the steps discussed below in one operation.

Pre-treatment. As already mentioned above, pre-treatment with steam or short immersion in boiling water will probably be the most suitable for plasticizing the laminae and thus rendering them suitable for subsequent shaping. Under certain conditions, prolonged immersion in a saturated solution of urea resin may be employed. In the latter case, the shaping has to be carried out (after drying) at an elevated temperature.[6] The two main shapes which can be seen in Fig. 2 present two entirely different problems in the treatment. The tubular shape is eminently suitable for a spiral-winding process, while the other shape will have to be carried out in three steps if the usual caul-shaping methods are practicable.

Gluing. The application of glue is relatively simple if dry glue films can be used between the wood layers, as no special measures must be taken for the elimination of surplus glue, and the glue is spread uniformly. On the other hand, the lamination has to be carried out at a fairly high temperature and pressure, according to the grade of the glue film. Such facilities may not be available.

Liquid glue can be applied to the curved surfaces just as ordinary glue is applied when veneering curved surfaces, and the use of glue spreader rollers is also practicable There are, however, newer devices being developed to facilitate this operation and to increase the accuracy and uniformity of the spreading. (*Please turn to next page*)

Pressing. Whatever the actual pressure under which the laminae are bonded, we have to provide some means of securing the correct position of the laminations until the structure becomes entirely self-supporting. By using certain synthetic resin glues of the liquid type, pressure is required to ensure the accuracy of the laminated shape and to economize on the quantity of glue used. Although the pressure used for building up a lamination such as illustrated on our example could hardly be less than 40 to 50 lb. per sq. in., it may be worth noting that there are some phenolic glues which theoretically would bond even without pressure. That means that the work can be carried out in the same manner as with glues which are already well known to cabinet makers; and even such ancient methods as the pressing with hot sandbags or in a "sandbox" are theoretically practicable, although we have the modern counterparts of these systems. The most versatile modern process is the arrangement which makes use of rubber bags so that the desired shape can be subjected to perfectly uniform pressure controlled by air pressure and suction. This process is generally combined with heat treatment such as autoclaving.

Finishing stages. After the laminated bodies have been sawed into frame elements (see *C*, Fig. 2), the next processes are the concern of the cabinet maker and decorator. We therefore omit the details referring to cabinet-making, upholstery and other finishing operations. It is obvious that the success of the production on the whole depends upon the range of purposes to which the half-finished articles can be put. The large-scale producer will have to supply with the half-finished frames a set of full instructions and suggestions (plans) so as to ensure the proper use of the product. These instructions should deal with joining, finishing and polishing treatments. The higher the resin content of the laminated frame, the greater the need for cooperation between the plastics technician and the furniture manufacturer.

We may sum up, therefore, by saying that rigid standardization should be enforced in the half-finished stage (*B*), while with the manner of sawing we can already produce a large number of frames of varied dimensions (*C*), the different combinations of which may result in an almost infinite number of finished products.

Conclusion

It must be understood that the development studies in Figs. 1 and 2 are merely sketches prepared to illustrate the fact that design, process and the choice of raw materials are parts of the same problem. These sketches are not intended to refer to current practice. It can be seen that we need still more research in the adaptation of plastic raw materials in order to produce the most suitable modifications of the resins simultaneously with the development of new techniques. At the same time we have to study design considerations from the very beginning. There can be no doubt that the most economical production calls for arrangements in which the *minimum number of stock-mold shapes will produce the maximum number of finished variations.*

References

[1] "Laminated Bends," report on test carried out by the Forest Products Research Board, reprinted in *Wood*, 11–14 (Jan. 1942).

[2] Mimeograph issued by the Forest Products Laboratory entitled "Plastic-Wood" (U. S. Forest Service).

[3] "Chemical Bending," test report reprinted by the permission of the Department of Scientific and Industrial Research in *Wood*, 123–126 (July 1942).

[4] "Foamed Synthetic Glue for Plywood," *Plastics*, 216–217 (Nov. 1941).

[5] Article by A. G. Knight, *Wood* (June 1942).

[6] "Eccentric Bends," report reprinted by the permission of the Department of Sc. & Ind. Res. in *Wood*, 60–61 (March 1942).

[7] "Plastic Building Components," G. Fejér, *Plastics*, 241–251 (Aug. 1942).

Classified Advertisements

All classified advertisements payable in advance of publication. Rates: $5.00 up to sixty words; enclosed in border, $10.00 per inch. Publisher reserves the right to accept, reject or censor all classified copy.

WANTED: THERMOPLASTIC SCRAP or rejects in any form, including Acetate, Butyrate, Styrene, Acrylic and Vinyl Resin materials. Submit samples and details of quantities, grades and color for our quotation. Reply Box 508, Modern Plastics.

WANTED: PLASTIC SCRAP OR REJECTS in any form, Cellulose Acetate, Butyrate, Polystyrene, Acrylic, Vinyl Resin, etc. Also wanted surplus lots of phenolic and urea molding materials. Custom grinding and magnetizing. Reply Box 318, Modern Plastics.

FOR SALE: 400 Ton Horizontal Hydraulic Extrusion Press. Hydraulic Scrap Baler, 80 Ton. Ball & Jewell #1½ ball bearing Rotary Cutter. Werner & Pfleiderer Jacketed Mixers, Laboratory size and 150 gallon. Large stock of Hydraulic Presses, pumps and accumulators, preform machines, rotary cutters, mixers, grinders, pulverizers, tumbling barrels, gas boiler, etc. Send for bulletins #138 and L-19. We also buy your surplus machinery for cash. Stein Equipment Co., 426 Broome St., New York City.

WILL PURCHASE PART INTEREST (or all) in plant to manufacture plastic items. Must have compression or injection machines. Have ideas and can make valuable contribution for post-war business and expansion. All replies treated confidential. Reply Box 733, Modern Plastics.

WANTED: Hydraulic Presses, Preform Machine and Mixer. Stainless Steel or Nickel Kettles, Vacuum Pan. No dealers. Reply Box 275, Modern Plastics.

FOR SALE: 1—Triplex Hydraulic Pump 2.85 g.p.m. at 3500# pressure; 1—Hydro-Accumulator 2500 PSI, 16½ gals., complete with tank, compressor and piping; 1—W. S. 15" x 18" Hydraulic Press, 10" dia. ram; 2—D. & B. 20½" x 20½" platens; 1—14" x 24" Press, 9" ram; 9—24" x 55" Steel Cored Heating Platens; 1—Farrel Birmingham 15" x 36" Rubber Mill; 4—W. P. Mixers; 1—Set of Compound Rolls 15" x 36"; Adamson 6" Tuber; Dry Mixers; Pulverizers, Grinders, etc. Send for complete list. Reply Box 446, Modern Plastics.

CHEMICAL ENGINEER: Position open for man thoroughly experienced in the fabrication and production of plastic materials. Must have complete knowledge of injection and compression molding technique and machines, as well as mold design. Also ability to take complete charge of and operate modern, well-equipped plant. Permanent position for qualified man, not just for the duration. Give complete details. Information will be kept confidential. Reply Box 726, Modern Plastics.

WANTED: Experienced molder of plastics for the development of molding equipment and the molding of asphaltic products. This work in development stage: company owns patents on molded asphaltic products. One of the largest independent petroleum refiners in midwest. Reply Box 738, Modern Plastics.

WANTED: Injection Machines, 4 and 6 oz. Write stating full details as to size, manufacturer, serial number, age, condition and price. Reply Box 747, Modern Plastics.

CHEMIST OR CHEMICAL ENGINEER: Large New England manufacturer seeks man with several years experience in the use of synthetic resins. Should have knowledge of laminating and molding with high and low pressure types and the modification of resins to meet specification requirements. Please include in first letter of application information regarding education, experience and salary expected. Reply Box 742, Modern Plastics.

WANTED: Plastics Production Man with mechanical design background and experience in compression molding, injection molding and extruding of thermoplastics. Large, financially sound, Chicago manufacturer offers excellent opportunity for right man to take over management of new and rapidly expanding Plastics Department devoted to production of industrial and war products. Reply Box 748, Modern Plastics.

SALES REPRESENTATIVE: Married man, age 30, sales ability and experienced in industrial plastics wishes permanent position as representative for Detroit, Michigan area. Reply to Box 741, Modern Plastics.

WANTED: Catalin scrap in any quantities. Also Catalin Rods, Tubes, Sheets—any colors. Will buy Catalin Equipment. Tell us what you want to sell. Send samples of material if possible. Reply Box 734, Modern Plastics.

WANTED—Salesman (salary basis) who thoroughly understands thermoplastic materials and their suitability for specified applications. Reply giving experience, draft status. Box 746, Modern Plastics.

WANTED: CHEMIST OR CHEMICAL ENGINEER: Man with experience with synthetic resins as well as college training. Give full particulars concerning experience, training, draft status, age, salary, etc. An opportunity to do research work on plastics. Location South Carolina. Reply Box 739, Modern Plastics.

FOR SALE: Industrial tract containing approximately 25,000 sq. ft. near Wabash Railroad and Mueller Brass Co. Ideal site for plastic or other factory. Staley Starch, Archer-Daniels and Spencer Kellogg soy bean manufacturers are located in Decatur, Illinois; "Soy Bean City of the World." Population 70,000. Center of State. Inexhaustible water supply in Lake Decatur. William Donovan, 152 Maple Drive, Beverly Hills, Calif.

FOR SALE: Motor Driven Air Compressor, Size 12 x 10, 260 cu. ft. displacement, 100 lbs. pressure. Reply Box 512, Modern Plastics.

WANTED: Isoma Injection Molding Machine, or Injection Machine of other make; further, Steel Steam Platens in various sizes for use in Hydraulic Presses. Reply Box 725, Modern Plastics.

THOROUGHLY EXPERIENCED EXECUTIVE WANTED for compression molding plant. Take complete charge of all operations; costs, production, engineering. Assist executives developing sales. Excellent salary; molding plant in operation 25 years. Established peacetime sales connections, now ready to enlarge and develop. Parent company in business over half century. All replies confidential. Reply Box 750, Modern Plastics.

SALES ENGINEERS OFFER FACILITIES TO EXTRUDER. A firm of sales engineers, operating throughout Northern New Jersey, Connecticut and New York State for more than twenty-five years, have the facilities to contact accounts for an extruder of plastics. Background and training in the plastics field, plus close association with key accounts throughout this territory, enable us to give such a manufacturer the representation he needs. Especially qualified in development and government contact. Excellent references. Financially able and stable. Box 729, Modern Plastics.

WANTED: Preforming press, preferably rotary, to make 3" tablet; die fill 1½". Reply Box 740, Modern Plastics.

MAN WITH WIDE EXPERIENCE in the research and development of phenolic and related resins and plastics interested in making contact now with a North or South American firm for the post-war development of resins and plastics in South America. Reply Box 731, Modern Plastics.

PLASTICS ENGINEER—Graduate metallurgist, extensive experience in products design, die design, and mechanical operation of thermoplastic extrusion equipment operating on acetate, butyrate, ethyl cellulose, vinyl and acrylic resin. Desires position with aircraft company developing applications for extruded plastics, or with raw material supplier improving extrusion technique. Dependents. Employed. Reply Box 736, Modern Plastics.

WANTED: Paper dryer or complete coating machine, also other equipment. Used paper dryer or complete pyroxylin or similar paper coating machine up to 54" wide. Also 50-gal. and 300–500 gal. mixers, filter presses. Not a dealer. Write full details. P. O. Box 270, Morristown, N. J.

FOR SALE: One No. 2 John Royle jacketed extrusion press, in good condition. I. L. Wise, 105 West Adams St., Chicago, Ill.

WANTED: Foreman for plastic compression molding plant. War work. Also post-war assurance. State experience and salary desired. Reply Box 749, Modern Plastics.

PLASTICS ENGINEER OR MAN: Opportunity open with long established company having extensive research and development program. Position is available for development work in plastics. Man desired must be thoroughly grounded in thermoplastics. This is an unusual opportunity for an engineer or man with the right technical and mechanical qualifications. Inquiries will be held in strictest confidence. Reply Box 743, Modern Plastics.

FOR SALE: One 60" Lehman Bros. Putty Chaser in good condition. Has stainless steel shafts and blades, solid granite 12" x 24" stones, belt driven. One #80R Derringer hammermill, belt driven. One Day single blade mixer, 50 gallon capacity with 3 H.P. motor. One Day 2 roll 14" x 9" paint mill. Reply Box 732, Modern Plastics.

FOR SALE: Two Watson-Stillman hydro pneumatic accumulators with air compressor and one triple riveted air tank. Will sell in one lot only. Also 1 large blower and 1 Grinder for grinding bakelite scrap. Reply Box 744, Modern Plastics.

EQUIPMENT WANTED: Two hydraulic presses approximately 250 ton each 15" by 20" platen, 12" by 14" ram, pressure in excess of 2000 lbs. per square inch, must be equipped with pull back cylinder. 150 lb. steam pressure boiler with all auxiliaries. Vickers oil pump 1 or 2000 lbs. per square inch. Reply Box 735, Modern Plastics.

SYNTHETIC RESIN CHEMIST desired by industrial organization in Philadelphia area. In answering please state age, education, draft status, experience including resin experience, salary desired and submit photograph. Reply Box 745, Modern Plastics.

SALES AGENCY will handle on commission basis any plastic items for the wholesale drug, infant, notion jobbers, and merchandise chains. Can arrange for New York warehouse if necessary. Reply Box 727, Modern Plastics.

PLASTICS INSTRUCTOR—PART TIME WORK. A successful Midwest school now about to open plastics training departments in various large cities of the Middle West is desirous of contacting plastics engineers or others who are capable of teaching all branches of plastics. Two instructors will be required in each city to devote 2 evenings per week to this work. Please answer fully giving age, education, present employment, if any, and other pertinent details. Reply to Box 737, Modern Plastics.

MAN: Familiar with thermoplastic materials and who is capable of developing new methods and processes. An opportunity for a man with ideas and imagination. Man must have mechanical training as well as theoretical knowledge. R. D. Werner Co., Inc., 380 Second Ave., N. Y. C.

WANTED: To purchase plastic molding business. An eastern War industry desirous of increasing its contribution to the War Effort wishes to buy a modern molding plant consisting of injection, compression, or extrusion equipment. Reply Box 730, Modern Plastics.

ENGINEER operating small plant with defense contracts independently on aircraft plastics would like to combine with other operator for handling larger developments. Present plant operating with small production facilities, additional equipment definitely required. Exceptional opportunity for manufacturer interested in aircraft parts who may be short in product and process engineering together with aircraft contacts but who has ample manufacturing facilities. Reply Box 724, Modern Plastics.

Index to Advertisements

Modern Plastics

Published by MODERN PLASTICS, INC.
122 E. 42nd St. NEW YORK, N. Y.